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PROCEEDINGS

OF THE

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THOMAS COLE

ASSOC. M. INST. C.E.

(Secretary of the Association)

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CONTENTS.

Frontispiece Portraits—

1. The late Robert Vawser, M. Inst. C.E., *Past President.*
2. Joseph Lobley, M. Inst. C.E., *Past President.*
3. Edward B. Ellice-Clark, M. Inst. C.E., *Past President.*
4. Alfred M. Fowler, M. Inst. C.E., *Past President.*

PAGE

LIST OF OFFICERS v
LIST OF MEMBERS vii
LIST OF TOWNS AND DISTRICTS REPRESENTED xxii
DISTRICTS xxxii
LIST OF GRADUATES lxii
PARLIAMENTARY COMMITTEE lxiii
BYE-LAWS lxiv

ANNUAL REPORT AND FINANCIAL STATEMENT FOR YEAR ENDING APRIL 30th, 1895 1–7
APPOINTMENT OF SCRUTINEERS 6
„ „ AUDITORS 6

MEETING AT BRUSSELS AND ANTWERP 8

The Brussels Municipal Electric Light Station. (Plates) 8
„ „ Gasworks 16
„ „ Electric Tramways 18
Reception at the Hotel de Ville 21
Antwerp Waterworks 23

DISTRICT MEETINGS—

MEETING AT BUSHEY AND HAMPSTEAD:

Colne Valley Waterworks: Bushey Pumping Station. E. B. Taylor. (Plate) 35
Discussion 41
Visits to Works 42
Hampstead Electric Lighting Installation. W. H. Preece 43
Discussion 48

MEETING AT MIDDLESBROUGH:

Discussion on Arrangements for Sterilising Cholera Dejecta, &c., adopted at Newcastle-on-Tyne (W. G. Laws) 52
The River Tees Floating Hospital, belonging to the River Tees Port Sanitary Authority. T. W. Stainthorpe. (Plates) 55
Discussion 63
Visit to Works 68

MEETING AT WESTMINSTER:

Private Drains or Public Sewers. W. N. Blair. (Plate) 69
Notes on Combined Drainage. R. Godfrey. (Plate) 75
Discussion 89

41080

DISTRICT MEETINGS (*continued*)—

MEETING AT STOCKPORT :

PAGE
Stockport Sewerage Scheme and Mersey Mill Bridge. A. M. Fowler 104
Municipal Progress at Stockport. J. Atkinson. (Plate) 112
Discussion 123
Visits to Works 126

MEETING AT BRIGHTON :

Resignation of O. C. Robson and election of G. B. Laffan as Hon. Secretary, Home Counties District 127
Brighton and its Municipal Works. F. J. C. May 128
Discussion 152
Points of Interest in the Development of Electricity Supply at Brighton. A. Wright. (Illustrated) 153
Discussion 161
The Supply and Distribution of Water at Brighton. J. Johnston. (Plate) 163
Discussion 170
Visits to Works 170

MEETING AT CARDIFF :

Some of the Recent Public Works of Cardiff. W. Harpur 172
Discussion 193
Visits to Works 195

MEETING AT PLYMOUTH :

Plymouth and its Municipal Works. J. Paton. (Plates) 197
The Water Supply of Plymouth. E. Sandeman 212
Discussion 221
Visits to Works 223

MEETING AT KESWICK AND THIRLMERE :

Visit to Threlkeld Quarries 224
Visit to Thirlmere Lake (Plate) 227

ANNUAL MEETING AT HALIFAX :

The President's Address 233
Royton Sewage Works. T. S. McCallum and W. Naylor. (Plates) 241
Discussion 255
Sewage Farm Management. Lieut.-Col. A. S. Jones 266
Discussion 271
Park and Garden Architecture. T. H. Mawson 273
Trade Effluents. W. Spinks 287
Halifax Waterworks. J. A. Paskin 299
Visits to Works 301

APPENDIX :

List of Books of Statistics at Offices of the Association 304
Examinations 308
Board of Examiners 318
Certificated Candidates 319

MEMOIRS OF DECEASED MEMBERS 323

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Garrett, J. H.	County Surveyor, Worcester.

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Golder, T. C.	Borough Surveyor, Deal.
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Gow, W. C.	Vestry Surveyor, Vestry Hall, Plumstead.
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Gray, W. H.	Borough Surveyor, Tewkesbury, Gloucestershire.
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Hawkins, I. T.	Town Surveyor, Somerton, Somersetshire.
Hawley, G. W.	Surveyor to the Nottingham District Highway Board, Nottingham.
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Mawson, R. C.	Borough Surveyor, Evesham.
Mawson, Jno.	Surveyor, Shaw, near Oldham.
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Murch, P.	Borough Engineer, Portsmouth.
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Richardson, R.	Surveyor to the Urban District Council, Malton.
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Stainthorpe, T. W. (*Member of Council*)	Surveyor to Eston District Urban District Council, Yorkshire; *Hon. Sec.*, Yorkshire District.
Stallard, S.	Surveyor to the Rural District Council, Maidstone.
Stead, S.	Borough Surveyor, Harrogate.
Stephenson, E. P., Assoc. M. Inst. C.E.	Town Surveyor, Llandudno.
Stevens, George	Surveyor to the Urban District Council, Abercarn, Mon.
Stevens, L.	Surveyor to the Urban District Council, Newton Abbott, Devon.
Stevenson, A.	District Surveyor, Ayrshire County Council.
Stevenson, J.	Surveyor to Urban District Council, East Molesey.
Stickland, E. A., Assoc. M. Inst. C.E.	Borough Surveyor, Newbury.
Stirrat, J.	Municipal Engineer, Rangoon.
Stokoe, J.	Surveyor to Urban District Council, Altrincham.
Story, J. S., M. Inst. C.E.	County Surveyor, Derby.
Stringfellow, H. W.	City Surveyor, Chichester.
Stringfellow, W., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, East Cowes, Isle of Wight.
Stuart, J. C.	Surveyor to Urban District Council, Smethwick.
Stubbs, Wm., A.M.Inst.C.E.	Borough Surveyor, Darwen.
Sumner, F., A. M. Inst. C.E.	Vestry Surveyor, Bermondsey.
Surtees, R. T.	Wentworth Place, Hexham-on-Tyne.
Sutcliffe, A.	Surveyor to the Urban District Council, Featherstone, near Pontefract.
Swarbrick, Joseph, Assoc. M. Inst. C.E.	33 Brasenose Street, Albert Square, Manchester.
Swindlehurst, J. E., Assoc. M. Inst. C.E.	Borough Surveyor, Burton-upon-Trent.
Sykes, Ed., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Cheadle, Manchester.
Tanner, W.	County Surveyor, Monmouthshire. Newport.
Tarbit, T. H.	Surveyor to the Urban District Council, Loftus, Yorkshire.
Taylor, H. W.	Surveyor to the Urban District Council, Newburn-on-Tyne.
Terrill, W.	Surveyor to Urban District Council, Ashford, Kent.
Thomas, John, A.M.Inst.C.E.	Surveyor to the Rural District Council, Swansea.
Thomas, R. J., A.M.Inst.C.E.	County Surveyor, Bucks. Aylesbury.
Thomas, T. J., A.M.Inst.C.E.	Surveyor to Urban District Council, Ebbw Vale.
Thomas, W.	Surveyor, Port Talbot, S. Wales.
Thomas, W., A. M. Inst. C.E.	Surveyor, Dover.
Thomas, W. E. C., A.M. Inst. C.E. (*Member of Council.*)	Surveyor to the Rural District Council, Neath; *Hon. Secretary*, South Wales District.
Thorburn, T. C.	17 Devonshire Road, Birkenhead.
Thorpe, Jas.	Surveyor to Rural District Council, Macclesfield.
TILL, W. S., M. Inst. C.E. (*Past President.*)	Borough Engineer, Birmingham.
Tomes, G. B.	Surveyor to the Barnes District Urban District Council, Mortlake.
Tomkins, H., A. M. Inst. C.E.	Vestry Surveyor, St. Marylebone.
Tooley, H.	Surveyor to the Urban District Council, Buckhurst Hill, Essex.
Towlson, S.	Surveyor to the Urban District Council, Cheshunt.

TRAVERS, W. H.	Surveyor to Urban District Council, Wavertree.
TROW, S.	Surveyor to the Urban District Council, Otley, Yorkshire.
TULEY, W.	Surveyor to the Urban District Council, Rothwell.
TURNBULL, A. J.	Borough Engineer, Greenock.
TURLEY, A. C., A.M.Inst.C.E.	Borough Engineer, Eccles.
VALLANCE, R. F.	Borough Surveyor, Mansfield.
VALON, W. A. McINTOSH, Assoc. M. Inst. C.E.	Ramsgate Corporation Gasworks Engineer; and 140 and 141 Temple Chambers, Temple Avenue, E.C.
VEEVERS, H., A. M. Inst. C.E.	Surveyor to Urban District Council, Dukinfield.
VENTRIS, A., Assoc. M. Inst. C.E.	Surveyor to the Strand District Board of Works. 49 Seymour Street, Portman Square.
WADDINGTON, J. A. P., Assoc. M. Inst. C.E.	Vestry Surveyor, Whitechapel.
WAKELAM, H. T., Assoc. M. Inst. C.E.	County Surveyor, Hereford.
WALKER, T., M. Inst. C.E. (*Member of Council.*)	Borough Surveyor, Croydon, Surrey.
WALLACE, G.	Surveyor to St. Giles' District Board of Works.
WALSHAW, J. W.	Borough Surveyor, Peterborough.
WARDLE, J. W., A.M.Inst.C.E.	Borough Surveyor, Longton.
WATERHOUSE, D.	Surveyor to the Urban District Council, Watford.
WATKEYS, G., A.M.Inst.C.E.	Surveyor to the Urban District Council, Llanelly.
WATSON, J. D., A.M.Inst.C.E.	County Engineer, Aberdeenshire.
WATTS, E. T.	Surveyor to the Rural District Council, Bishop's Stortford.
WATTS, W.	Water Engineer, Oldham.
WAYE, H.	Surveyor to the Urban District Council, Millom, Cumberland.
WEAVER, WM., M. Inst. C.E. (*Member of Council.*)	Vestry Surveyor, Kensington.
WEBSTER, J. L.	Surveyor to the Urban District Council, Portland.
WEBSTER, R. J.	Surveyor to the Urban District Council, Castleton, Manchester.
WELBURN, W.	Borough Surveyor, Middleton, near Manchester.
WESTON, GEO.	Vestry Surveyor, Paddington.
WESTON, H. J., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Shirley and Freemantle, Southampton.
WETHERILL, J. W.	Surveyor to Urban District Council, Rawmarsh.
WHEELER, G. R. W., Assoc. M. Inst. C.E. (*Member of Council.*)	Vestry Surveyor, Westminster; *Hon. Secretary*, Metropolitan District.
WHITBREAD, R.	Surveyor to the Urban District Council, Carlton, Notts.
WHITE, A. E., M. Inst. C.E.	Borough Engineer, Hull.
WHITE, H. V., M. Inst. C.E. I.	County Surveyor, Queen's County. Portarlington.
WHITE, J., Assoc.M.Inst.C.E.	Borough Surveyor, Folkestone.
WHITE, W. H., M. Inst. C.E. (*Past President.*)	City Engineer, Oxford.
WHITEHEAD, C. L., jun.	Surveyor to the Urban District Council, Chesham, Bucks.
WIDDOWSON, W. C.	Surveyor to the Urban District Council, Tredegar, Mon.
WIKE, C. F., M. Inst. C.E. (*Member of Council.*)	Borough Engineer, Sheffield.
WILD, G. H.	Surveyor to Urban District Council, Littleborough, near Manchester.
WILKINSON, J. P., Assoc. M. Inst. C.E.	Assheton Road, Clayton Bridge, Manchester.

Williams, H. D.	Surveyor to the Urban District Council, Ogmore and Garrw, Bridgend.
Williams, J. B.	Borough Surveyor, Daventry.
Willcox, J. E., Assoc. M. Inst. C.E.	63 Temple Row, Birmingham.
Willmot, J.	County Surveyor, Warwickshire. 6 Waterloo St., Birmingham.
Willson, F. R. T.	County Surveyor, Co. Fermanagh, Enniskillen.
Wilson, C. L. N., Assoc. M. Inst. C.E.	Town Surveyor, Bilston.
Wilson, Geoffrey	Surveyor to the Urban District Council, Alnwick.
Wilson, J.	Borough Surveyor, Bacup, Lancashire.
Wilson, J. B.	Surveyor to the Rural District Council, Cockermouth.
Window, E. R., A.M.Inst.C.E.	16 Cook Street, Liverpool.
Winship, G., A. M. Inst. C.E.	Borough Surveyor, Abingdon, Berks.
Wood, A. R.	Surveyor to the Urban District Council, Tunstall.
Wood, F. J.	County Surveyor, Hubert Place, Lancaster.
Woodbridge, C. A.	Surveyor to the Hendon Union Rural District Council. Pinner, Middlesex.
Woods, Hy.	District Surveyor, Plumstead (Parishes of Lee and Kidbrook). Dryden Terrace, Turner Road, Lee, Kent.
Worth, J. E., M. Inst. C.E.	District Engineer, London County Council, Spring Gardens, S.W.
Wright, A., A.M. Inst. C.E.	Electrical Engineer, Brighton.
Wyatt, W. J.	Surveyor to the Urban District Council, Paignton, Devon.
Wynne-Roberts, R. O., Assoc. M. Inst. C.E.	Borough Surveyor, Oswestry.
Yabbicom, T. H., Assoc. M. Inst. C.E.	Borough Engineer, Bristol.
Yates, F. S., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Waterloo, near Liverpool.
York, H.	Surveyor to the Urban District Council, East Barnet Valley. Station Road, New Barnet.

TOWNS AND DISTRICTS

REPRESENTED BY MEMBERS OF THE ASSOCIATION.

Abercarne	G. Stevens.
Aberdeen	W. Dyack.
Aberdeenshire	J. D. Watson.
Abergavenny	Jon. Haigh.
Abersychan	E. Cooke.
Abingdon	G. Winship.
Abram	Geo. Heaton.
Accrington	W. J. Newton.
Acton	D. J. Ebbetts.
Allerton	A. O. Fraser.
Alnwick	G. Wilson.
Altrincham	J. Stokoe.
Alverstoke	W. H. Fry.
Antrim (County).	J. H. Brett.
Armagh (County)	R. H. Dorman.
Ashby-de-la-Zouch	G. H. Lilley.
Ashby Woulds	C. T. Garratt.
Ashford	W. Terrill.
Ashton-under-Lyne	J. T. Earnshaw.
Aspull	Geo. Heaton.
Aston	H. Richardson.
„ (Rural)	R. H. Hawgood.
Atherstone (Rural)	W. R. H. Chipperfield.
Atherton	W. Clough.
Audenshaw	J. H. Burton.
Aylesbury	J. H. Bradford.
Ayrshire (County)	A. Stevenson.

Bacup	J. Wilson.
Bamber Bridge	F. E. Dixon.
Barking	C. J. Dawson.
Barmouth	T. Blackburn.
Barnes	G. B. Tomes.
Barrow-on-Soar (Rural)	H. Herrod.
Barry	J. C. Pardoe.
Barton-upon-Irwell	C. C. Hooley.
Batley	Hy. Dearden.
Battersea	J. T. Pilditch.
Beckenham	J. A. Angell.
Bedford	J. Lund.
„ (County)	W. H. Leete.
Bedlington	W. W. Cooper.
Belfast	J. C. Bretland.
Benwell	W. P. Pattison.
Bermondsey	F. Sumner.
Berwick-on-Tweed	R. Dickenson.
Bethnal Green	F. W. Barratt.
Bexhill	M. D. Graves.
Biggleswade	G. W. Manning.

Billesden (Rural)	W. F. Ault.
Bilston	C. L. N. Wilson.
Bingley	R. Armistead.
Birkenhead	C. Brownridge.
Birmingham	W. S. Till.
„	E. Pritchard.
Bishop's Castle	A. Hamar.
Bishop's Stortford	R. S. Scott.
„ „ (Rural)	E. T. Watts.
Blaby (Rural)	W. King.
Blaydon-on-Tyne	W. S. Simpson.
Bolton	W. H. Brockbank.
Bombay	M. C. Murzban.
Bootle	J. A. Crowther.
Bournemouth	F. W. Lacey.
Bowdon	J. Newton.
Brackley	A. A. Green.
Bradford	J. H. Cox.
Braintree	J. H. Jevons.
Bray	P. F. Comber.
Brecknock	R. Davies.
Brentford	N. Parr.
Bridgwater	F. Parr.
Bridlington	R. R. Brown.
Brierfield	J. T. Landless.
Brierley Hill	J. W. Beckley.
Brighton	F. J. C. May.
Brisbane, Queensland	T. Kirk.
Bristol	T. H. Yabbicom.
„ (St. George)	T. L. Lewis.
Bromley	S. T. Hawkings.
Brownhills	J. H. Shaw.
Buckhurst Hill	H. Tooley.
Buckingham (County)	R. J. Thomas
Burnham	W. J. Press.
Burnley	F. S. Button.
„ (Rural)	S. Edmondson.
Burslem	F. Bettany.
Burton-upon-Trent	J. E. Swindlehurst.
Bury	J. Cartwright.
Bury St. Edmunds	J. C. Smith.

Canterbury	A. H. Campbell.
Cape Town, S.A.	T. W. Cairncross.
Cardiff	W. Harpur.
„ (Rural)	W. Fraser.
Carlisle	W. H. Smith.
Carlton	R. Whitbread
Carshalton	T. L. Heward
Castleton	R. J. Webster.
Cavan (County)	R. N. Somerville.
Chadderton	W. Eckersley.
Chapeltown, Jamaica	W. Parker.
Charlton	J. Rowland.
Cheadle	E. Sykes.
Chelmsford	G. H. Sasse.
„ (Rural)	I. C. Smith.
Chelsea	T. W. E. Higgens.
Cheltenham	Jos. Hall.
Chesham	C. L. Whitehead, jun.
Cheshunt	S. Towlson.

Chester	I. M. Jones.
Chesterfield	N. Dunscombe.
Chesterton	D. Bland.
Chichester	H. W. Stringfellow.
Chorley	W. Leigh.
Clacton-on-Sea	A. R. Robinson.
Clapham, S.W.	A. Southam.
Cleator Moor	F. J. Edge.
Clerkenwell	W. Iron.
Clevedon	G. W. Knowles.
Cockermouth	R. S. Marsh.
„ (Rural)	J. B. Wilson.
Colchester	H. Goodyear.
Colwyn Bay	W. Jones.
Compton Gifford	J. C. Inglis.
Congleton	R. Burslam.
Conway	T. B. Farrington.
Cookham	F. Laurens.
Cork (County), West	N. Jackson.
„ „ South	S. A. Kirkby.
„ „ East	A. O. Lyons.
Cornwall (County), West	T. J. Hickes.
Coseley	C. W. Shackleton.
Coventry	E. J. Purnell.
Cowpen	R. Grieves.
Crewe	G. Eaton-Shore.
Cromer	A. F. Scott.
Crompton	J. H. Mills.
Croydon	T. Walker.

Dalton-in-Furness	C. C. Smith.
Darwen	W. Stubbs.
Daventry	J. B. Williams.
Deal	T. C. Golder.
Denton	G. H. Newton.
Derby	R. J. Harrison.
„ (County)	J. S. Story.
Desborough	O. Pemberton.
Dewsbury	H. C. Marks.
Doncaster	W. H. R. Crabtree.
„ (Rural)	C. C. Barras.
Dorchester	G. J. Hunt.
Dorking	G. S. Mathews.
„ (Rural)	W. Rapley, jun.
Down (County)	P. C. Cowan.
Droitwich	B. Godfrey.
Dublin	C. Harty.
„ (County)	R. A. Gray.
„ „ South Division	W. Collen.
Dudley	J. Gammage.
Dukinfield	H. Veevers.
Durham (Rural)	G. Gregson.

Ealing	C. Jones.
Eastbourne	R. M. Gloyne.
East Barnet Valley	H. York.
East Cowes	W. Stringfellow.
East Dereham	H. G. Himson.
East Ham	W. H. Savage.
East Molesey	J. Stevenson.

East Stonehouse	W. Stringfellow.
Ebbw Vale	T. J. Thomas.
Eccles	A. C. Turley.
Edinburgh	J. Cooper.
Eltham	R. Findlay.
Epsom	E. R. Capon.
Erith	H. Hind.
Eston District	T. W. Stainthorpe.
Evesham	R. C. Mawson.
Exeter	D. Cameron.
Exmouth	W. H. Beswick.
Eye	J. Rush.

Fareham	W. Butler.
Featherstone	A. Sutcliffe.
Felixstowe	G. S. Horton.
Fermanagh (County)	F. R. T. Willson.
Finchley	F. Smythe.
Fleetwood	M. S. Gaulter.
Folkestone	J. White.
Friern Barnet	E. J. Reynolds.
Frodsham	W. Diggle.
Frome	P. Edinger.
„ (Rural)	A. Greenwell.

Galway (County), West	J. Perry.
„ „ East	J. Smith.
Garston	H. T. Wakelam.
Gateshead-on-Tyne	J. Bower.
Gloucester	R. Read.
„ (County)	R. Phillips.
Glyncorrwg	J. Howell.
Godaveri, Madras	P. H. Brown.
Grantham	J. Evans.
Great Crosby	W. Hall.
Great Grimsby	M. Petree.
Great Yarmouth	J. W. Cockrill.
Greenock	A. J. Turnbull.
Guildford	F. T. Maltby.

Halifax	E. R. S. Escott.
Hammersmith	H. Mair.
Hampstead	C. H. Lowe.
Hampton	J. Kemp.
Hanley	J. Lobley.
Hants (County)	J. Robinson.
Hanwell	S. W. J. Barnes.
Harborne	R. Dixon.
Harrogate	S. Stead.
Harrow	T. Charles.
Hartlepool	H. C. Crummack.
Harwich	H. Ditcham.
Haverhill	T. Cockrill.
Heaton Norris	W. C. Sheard.
Hebden Bridge	W. Calvert.
Hendon	S. S. Grimley.
„ (Rural)	C. A. Woodbridge.
Henley-on-Thames	R. Pratt.
Hereford	J. Parker.
„ (County)	H. T. Wakelam.

Heywood	J. Diggle.
Heckmondwike	J. Saville.
High Wycombe	T. J. Rushbrooke.
Holborn	L. H. Isaacs.
Hong Kong	F. A. Cooper.
Horfield	A. P. J. Cotterell.
Hornsea	P. Gaskell.
Hornsey	E. J. Lovegrove.
Hounslow	W. A. Davies.
Hove	H. H. Scott.
Hoylake and West Kirby	T. Foster.
Hull	A. E. White.
Hyde	J. Mitchell.

Ilfracombe	O. M. Prouse.
Ilkeston	H. J. Kilford.
Ipswich	E. Buckham.
Irlam	W. R. Kay.
Isle of Ely (County)	G. J. Moore.

Jarrow	J. Petree.
Johannesberg, S.A.	C. Aburrow.
" "	G. R. Andrews.

Kearsley	T. Nuttall.
Keighley	W. H. Hopkinson.
Kennington Green	J. P. Norrington.
Kensington	W. Weaver.
Kent (County)	F. W. Ruck.
Keswick	W. Hodgson.
Kettering	T. R. Smith.
Kidderminster	A. Comber.
" (Highways)	G. J. Shepherd.
Kildare (County)	E. Glover.
Kilkenny	A. M. Burden.
King's County	R. B. Sanders.
King's Lynn	E. J. Silcock.
King's Norton (Rural)	R. Godfrey.
Kingston (Highway Board)	A. J. Henderson.
" (Rural)	W. H. Hope.
" Jamaica	C. V. Abrahams.
Kingswood	D. H. W. Powell.
Kirkleatham	J. Howcroft.

Lancaster	J. Cook.
Leamington Spa	W. De Normanville.
Lee	H. Woods.
Leeds	T. Hewson.
Leek	J. Myatt.
Leicester	E. G. Mawbey.
"	F. Griffiths.
Leith	W. Beatson.
Leitrim (County)	D. G. Ottley.
Levenshulme	J. Jephson.
Lewes	T. W. Franks.
Lewisham	J. Carline.
Leyton, E.	W. Dawson.
Lichfield	C. J. Corrie.
Limerick (County)	J. Horan.
Lincoln	R. A. MacBrair.
Littleborough	G. H. Wild.
Littlehampton	H. Howard.

Liverpool	H. P. Boulnois.
Llandaff	Jas. Holden.
Llandudno	E. P. Stephenson.
„	T. T. Marks.
Llanelly	G. Watkeys.
Llantrissant	G. S. Morgan.
Loftus	T. H. Tarbit.
London (County)	A. R. Binnie.
„ „	J. E. Worth.
Londonderry	W. J. Robinson.
„	J. Christie.
Longford (County)	J. W. Gunnis.
Longton	J. W. Wardle.
Loughborough	Geo. Hodson.
Louth (County)	P. J. Lynam.
Lowestoft	G. H. Hamby.
Lurgan	H. Shillington.
Lymington	O. A. Bridges.

Macclesfield	E. E. Adshead.
„ (Rural)	J. Thorpe.
Madras	R. E. Ellis.
Maidstone	T. F. Bunting.
„ (Rural)	S. Stallard.
Maldon	H. G. Keywood.
Malton	R. Richardson.
Malvern	H. P. Maybury.
Manchester	T. De C. Meade.
Mansfield	R. F. Vallance.
Mansfield Woodhouse	F. P. Cook.
Margate	A. Latham.
Market Harboro'	H. G. Coales.
Matlock Bath	W. Jaffrey.
Meath (County)	J. H. Moore.
Melton Mowbray	E. Jeeves.
Merthyr Tydvil	T. F. Harvey.
„ „ (Rural)	J. Jones.
Middlesbrough	F. Baker.
Middleton, Lancashire	W. Welburn.
Mile End	J. M. Knight.
Millom	H. Waye.
Milton-next-Sittingbourne	A. B. Acworth.
Mirfield	F. H. Hare.
Monaghan (County)	J. Heron.
Monmouthshire (County)	W. Tanner.

Neath (Rural)	W. E. C. Thomas.
Nelson	J. W. Bradley.
Nelson-in-Marsden	W. Dent.
Newark	G. Sheppard.
New Barnet	G. W. Brumell.
Newburn-on-Tyne	H. W. Taylor.
Newbury	E. A. Stickland.
Newcastle-on-Tyne	W. G. Laws.
Newcastle-under-Lyme	J. Pattison, jun.
New Malden	T. L. Heward.
Newmarket	J. W. Metcalf.
Newport, Mon.	R. H. Haynes.
Newton Abbott	L. Stevens.
Newton-in-Makerfield	R. Brierley.
Newtown	R. W. Davies.
Northampton	W. I. Brown.

Northampton (County)	E. Law.
North Bierley	P. Ross.
North Mayo (County)	W. P. Orchard.
North Ormesby	H. T. Hopper.
Norwich	A. E. Collins.
Nottingham	A. Brown.
„ (County)	E. P. Hooley.
Nuneaton	J. S. Pickering.

Ogmore and Garrw	H. D. Williams.
Okehampton	H. Geen.
Oldham	W. Watts.
Orrell	G. Heaton.
Oswestry	R. O. Wynne-Roberts.
Otley	S. Trow.
Oundle	J. M. Siddons.
Oxford	W. H. White.
Oystermouth	C. G. Bennett.

Paddington	Geo. Weston.
Padiham	J. Gregson.
Paignton	W. J. Wyatt.
Peebles (County)	R. S. Anderson.
Pemberton	Geo. Heaton.
Penang, Straits Settlements	R. Peirce.
Penarth	E. J. Evans.
Penmaenmawr	J. S. Coverley.
Perry Barr	H. H. Gammell.
Peterborough	J. W. Walshaw.
Plumstead	W. C. Gow.
Plymouth	J. Paton.
Pontardawe (Rural)	J. Morgan.
Poole	J. Elford.
Poplar	G. F. Holt.
Portishead	J. Moss Flower.
Portland	J. L. Webster.
Portsmouth	P. Murch.
Prescot	W. Goldsworth.
Putney	J. C. Radford.
Pwllheli	J. O. Jones.

Queen's County	H. V. White.

Rangoon	J. Stirrat.
Ramsbottom	T. Nuttall.
Ramsgate	W. Oxtoby.
„	W. A. M. Valon.
Rawmarsh	J. W. Wetherill.
Reigate	F. D. Clark.
Retford	J. D. Kennedy.
Richmond	J. H. Brierley.
Rochdale	S. S. Platt.
Rochester	W. Banks.
Rotherham	G. Jennings.
Rotherhithe	N. Scorgie.
Rothwell	W. T. Pearson.
„	W. Tuley.
Rowley Regis	W. H. Brettell.
Rugby	D. G. MacDonald.

Ryde	F. Newman.
Ryton-on-Tyne	J. P. Dalton.
Saffron Walden	G. W. Lacey.
Sale	A. G. McBeath.
Sandwich	A. J. Catt.
Scarborough	J. Petch.
Sevenoaks	J. Mann.
Shanghai, China	C. Mayne.
Sheerness	C. A. Copland.
Sheffield	C. F. Wike.
Sherborne	T. Farrall.
Shifnal, Salop	W. F. Y. Molineux.
Shildon	W. A. Mason.
Shirley and Freemantle	H. J. Weston.
Shrewsbury	W. C. Eddowes.
Shropshire (County)	A. T. Davis.
Skipton	T. Mallinson.
Skelton-in-Cleveland	W. P. Robinson.
Sleaford	Jesse Clare.
Slough	J. Baker.
Smethwick	J. C. Stuart.
Solihull (Rural)	A. E. Currall.
Somerton	I. T. Hawkins.
Southampton	W. B. G. Bennett.
South Brisbane	T. C. Deverell.
South Mayo	E. K. Dixon.
Southgate	C. G. Lawson.
South Hornsey	M. W. Jameson.
Southowram	W. H. D. Horsfall.
Southport	W. Crabtree.
South Shields	M. Hall.
Sowerby Bridge	F. Rothera.
Stafford	W. Blackshaw.
Stamford	Jas. Richardson.
Stapleton	A. J. Saise.
Stockport	J. Atkinson.
Stockton	K. F. Campbell.
Stourbridge	W. Fiddian.
Strand	A. Ventris.
Stratford-on-Avon	T. Rowland.
Streatham	Jas. Barber.
Stretford	H. Royle.
Strood	W. Brooke.
St. George, Bristol	T. L. Lewis.
St. George's, Hanover Square	G. Livingstone.
St. Giles	G. Wallace.
St. Helen's	G. J. C. Broom.
St. Leonard, Shoreditch	T. R. Roscoe.
St. Luke, Middlesex	M. C. Meaby.
St. Martin-in-the-Fields	C. Mason.
St. Mary, Islington	J. P. Barber.
St. Mary, Newington	J. A. P. Waddington.
St. Marylebone	H. Tomkins.
St. Pancras	W. N. Blair.
St. Saviour, Southwark	G. R. Norrish.
Suffolk (County), East	Hy. Miller.
Sunderland	R. S. Rounthwaite.
Surrey (County)	F. G. Howell.
Sussex (County), East	Hy. Card.
„ „ West	C. Adcock.
Sutton, Surrey	A. D. Greatorex.

Sutton Coldfield	C. F. Marston.
Sutton-in-Ashfield	McW. Bishop.
Swansea	G. Bell.
" (Rural)	J. Thomas.
Swinton	W. F. Pinfold.
"	H. Entwisle.
Sydney, N.S.W.	R. W. Richards.
Tamworth	H. J. Clarson.
Teignmouth	C. Jones.
Tettenhall	J. Mortimer.
Tewkesbury, Gloucestershire	W. H. Gray.
Tientsin, China	A. W. H. Bellingham.
Tipperary (County), South	E. A. Hackett.
" " North	J. O. Moynan.
Tipton	W. H. Jukes.
Todmorden	H. Shaw.
Tonbridge	A. F. Ginn.
Tooting	Jas. Barber.
Toowong, Queensland	W. E. Irving.
Torquay	H. A. Garrett.
Tottenham	J. E. Worth.
Toxteth Park	J. Price.
Tredegar	W. C. Widdowson.
Tunbridge Wells	T. E. W. Mellor.
Tunstall	A. R. Wood.
Turton	Jas. Parkinson.
Twickenham	G. B. Laffan.
Tyldesley	J. B. Smith.
Tynemouth	J. F. Smillie.
Upper Soothill	T. Fenn.
Ventnor	E. J. Harvey.
Victoria, Australia	J. C. Ross.
Wakefield	R. Porter.
" (Rural)	F. Massie.
Walham Green	C. Botterill.
Wallasey	A. Salmon.
Walsall	R. H. Middleton.
Wallsend	G. Hollings.
Walthamstow	G. W. Holmes.
Walton-on-the-Hill	S. Middlebrook.
Wandsworth	P. Dodd.
Wanstead	J. T. Bressey.
Wantage	W. Hanson.
Warminster	W. Bayley.
Warwickshire (County)	J. Willmot.
Waterford (County)	W. E. L. Duffin.
Waterloo, Liverpool	F. S. Yates.
Watford	D. Waterhouse.
" (Rural)	G. A. Heath.
Wavertree	W. H. Travers.
Wednesbury	E. M. Scott.
Wellingborough	E. Sharman.
West Bridgford	A. Smithies.
West Bromwich	J. T. Eayrs.
West Cowes	N. F. Dennis.
West Derby	F. C. Everett.
West Ham, London	L. Angell.
West Hartlepool	J. W. Brown.

Westminster	G. R. W. Wheeler.
Weston-super-Mare	H. Nettleton.
Weymouth and Melcombe Regis	W. B. Morgan.
Whitechapel	J. A. P. Waddington.
Whitehaven	J. S. Brodie.
Widnes	J. S. Sinclair.
Willesden	O. C. Robson.
Wimbledon	C. H. Cooper.
Wirksworth	A. R. Ridout.
Wisbech	A. H. Plowright.
Withington	A. H. Mountain.
Wolverhampton	J. W. Bradley.
Woodford	C. Mathew.
Wood Green	C. J. Gunyon.
Worcester	T. Caink.
„ (County)	J. H. Garrett.
Worksop	T. Kidd.
„ (Rural)	W. T. Brown.
Worthing	M. Aspinall.
Wrexham	J. W. M. Smith.
„ (Rural)	A. C. Baugh.
Yeovil	W. K. L. Armytage.
York	A. Creer.
„ (Rural)	W. G. Penty.
Yorkshire (East Riding)	A. Beaumont.

DISTRICTS.

No. 1.—THE HOME DISTRICT.

Hon. Secretary—G. W. Laffan, Twickenham.

MEMBERS.

Acworth, A. B.	Town Surveyor, Milton-next-Sittingbourne, Kent.
Adcock, C.	County Surveyor, Sussex (West).
Angell, J. A., A.M.Inst.C.E.	Surveyor to Urban District Council, Beckenham.
ANGELL, LEWIS, M. Inst. C.E. (*Past President and Treasurer*)	Borough Engineer, West Ham.
Aspinall, M., A.M.Inst.C.E.	Borough Engineer, Worthing.
Baker, J., A. M. Inst. C.E.	Town Surveyor, Slough.
Banks, W., A. M. Inst. C.E.	City Surveyor, Rochester.
Barnes, S. W. J., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Hanwell.
Bennett, W. B. G., Assoc. M. Inst. C.E.	Borough Surveyor, Southampton.
Binnie, A. R., M. Inst. C.E. (*Vice-President.*)	Chief Engineer, London County Council, Spring Gardens, S.W.
Bradford, J. H.	Borough Surveyor, Aylesbury.
Bressey, J. T.	Surveyor to the Urban District Council, Wanstead, Essex.
Bridges, O. A.	Borough Surveyor, Lymington.
Brierley, J. H.	Borough Surveyor, Richmond, Surrey.
Brooke, W., A. M. Inst. C.E.	Surveyor to the Rural District Council, Strood.
Brumell, G. W.	Surveyor to Urban District Council, New Barnet.
Bunting, T. F.	Borough Surveyor, Maidstone.
Butler, W.	Surveyor to the Urban District Council, Fareham.
Campbell, A. H.	City Surveyor, Canterbury.
Capon, E. R.	Surveyor to the Urban District Council, Epsom.
Card, H.	County Surveyor, Lewes.
Catt, A. J.	Surveyor to the Urban District Council, Sandwich.
Charles, T.	Surveyor to the Urban District Council, Harrow.
Chart, R. M.	Consulting Surveyor to the Rural District Council, Croydon.
Clark, F. D.	Borough Engineer, Reigate.
Cooper, C. H., A.M.Inst.C.E.	Surveyor to Urban District Council, Wimbledon.
Copland, C. A.	Surveyor to Urban District Council, Sheerness.
Copley, C. T.	Borough Engineer, Southend.
Cregeen, H. S.	Consulting Surveyor to the Urban District Council, Bromley, Kent.
Crimp, W. Santo, M. Inst. C.E.	District Engineer, London County Council, Spring Gardens, S.W.
Davies, W. A., A.M. Inst. C.E.	Town Hall, Hounslow.
Dawson, C. J.	Surveyor to the Urban District Council, Barking.
Dawson, W., A. M. Inst. C.E.	Surveyor to Urban District Council, Leyton, E.
DEACON, G. F., M.Inst.C.E. (*Past President.*)	32 Victoria Street, Westminster, S.W.
Dennis, N. F., A.M.Inst.C.E.	Town Surveyor, West Cowes.

Ditcham, H.	Borough Surveyor, Harwich.
Dodd, P., Assoc. M. Inst. C.E.	Surveyor, Wandsworth, S.W.
Dunscombe, C., M.A., M. Inst. C.E.	20 Victoria Street, Westminster.
Ebbetts, D. J.	Surveyor to the Urban District Council, Acton.
ELLICE-CLARK, E. B., M. Inst. C.E. (*Past President*).	Late County Surveyor for Sussex (West). 32 Victoria Street, Westminster, S.W.
Fairley, W., A.M.Inst.C.E.	Richmond Main Sewerage Board, Mortlake, S.W.
Forder, W. G.	Sunningdale, Thornton Heath.
Franks, T. W., A.M.Inst.C.E.	Borough Surveyor, Lewes.
Fry, W. H., A.M.Inst.C.E.	Surveyor to the Urban District Council, Alverstoke.
Gamble, S. G., Assoc. M. Inst. C.E.	Metropolitan Fire Brigade, Southwark Bridge Road.
Ginn, A. F.	District Surveyor to the Kent County Council, Tonbridge.
Gloyne, R. M., A.M.Inst.C.E.	Borough Surveyor, Eastbourne.
Golder, T. C.	Borough Surveyor, Deal.
Graves, M. D.	Surveyor to Urban District Council, Bexhill.
Greatorex, A. D., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Sutton, Surrey.
Grimley, S. S., A.M.Inst.C.E.	Surveyor to Urban District Council, Hendon.
Gunyon, C. J., A.M.Inst.C.E.	Surveyor to Urban District Council, Wood Green.
Hanson, W.	Surveyor to the Highway Board, Wantage.
Harding, J.R., A.M.Inst.C.E.	Surveyor to Urban District Council, Epsom, Surrey.
Harvey, E. J.	Surveyor to Urban District Council, Ventnor.
Hawkings, S. T.	Surveyor to the Urban District Council, Bromley.
Heath, G. A.	Surveyor to Rural District Council, Watford.
Henderson, A. J.	Surveyor to the District Highway Board, Kingston.
Heward, T. L.	Surveyor to the Urban District Councils, New Malden and Carshalton.
Hind, H.	Surveyor to Urban District Council, Erith.
Hodson, Geo, M.Inst.C.E.	Loughborough.
Holmes, G. W.	Surveyor to Urban District Council, Walthamstow.
Hooper, J. D.	Consulting Surveyor to the Urban District Council, Woodford, Essex.
Hope, W. H.	Surveyor to Rural District Council, Kingston-on-Thames.
Howard, H.	Surveyor to the Urban District Council, Littlehampton.
Howell, F. G.	County Surveyor, Kingston-on-Thames.
Jameson, M. W.	Surveyor to the Urban District Council, South Hornsey.
Jones, Lt.-Col. A. C., V. C., Assoc. M. Inst. C.E.	Junior United Service Club, S.W.
JONES, C., M.Inst.C.E. (*Past Pres. and General Hon. Sec.*)	Surveyor to the Urban District Council, Ealing, Middlesex.
Kemp, J., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Hampton, Middlesex.
Lacey, F. W., A.M.Inst.C.E.	Town Surveyor, Bournemouth.
Laffan, G. B., Assoc. M. Inst. C.E.	Engineer to the Urban District Council, Twickenham.
Latham, A., M. Inst. C.E.	Borough Engineer, Margate.
Laurens, F.	Surveyor to Rural District Council, Cookham.

Lawson, C. G., A.M.Inst.C.E.	Surveyor to Urban District Council, Southgate.
Leete, Wm. H., A.M.Inst.C.E.	County Surveyor, Bedford.
LEMON, J., M.Inst.C.E. (*Past President.*)	Consulting Engineer, Southampton.
Lockwood, P. C., M. Inst. C.E.	Late Borough Surveyor, Brighton, Sussex.
Lovegrove, E. J.	Surveyor to Urban District Council, Hornsey.
Lund, J.	Borough Surveyor, Bedford.
Maltby, F. T., A.M.Inst.C.E.	Borough Surveyor, Guildford.
Mann, Jabez, A. M. Inst. C.E.	Surveyor to Urban District Council, Sevenoaks.
Manning, G. W.	Surveyor to the Urban District Council, Biggleswade, Beds.
Mathew, C.	Surveyor to Urban District Council, Woodford.
Mathews, G. S., Assoc.M.Inst. C.E.	Surveyor to the Urban District Council, Dorking.
May, F. J. C., Assoc. M. Inst. C.E. (*Member of Council.*)	Borough Engineer, Brighton.
McKie, H. U., M. Inst. C.E.	11 Victoria Street, Westminster.
Mellor, T. E. W., Assoc. M. Inst. C.E.	Borough Surveyor, Tunbridge Wells.
Murch, P.	Borough Engineer, Portsmouth.
Newman, F.	Borough Engineer, Ryde, and County Surveyor, Isle of Wight.
Oxtoby, M., A. M. Inst. C.E.	Borough Surveyor, Ramsgate.
Pollard, J., Assoc. M. Inst. C.E.	Late Surveyor to the Urban District Council, Hendon. 7 Old Queen Street, Westminster.
Pratt, R.	Borough Surveyor, Henley-on-Thames.
Rapley, Wm., jun.	Surveyor to the Dorking Rural District Council.
Reynolds, E. J., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Friern Barnet.
Richards, Hy.	51 Grosvenor Road, S.W.
Richardson, R.	Surveyor to Urban District Council, Malton.
Robinson, J.	County Surveyor, Hampshire.
Robson, O. C., M. Inst. C.E. (*Vice-President.*)	Surveyor to the Urban District Council, Willesden, Middlesex.
Ruck, F. W.	County Surveyor, Kent, Maidstone.
Rushbrooke, T. J.	Borough Surveyor, High Wycombe.
Savage, Wm. Hy.	Surveyor to the Urban District Council, East Ham.
Scott, H. H., A. M. Inst. C.E.	Engineer to the Commissioners, Hove.
Scott, R. S., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Bishop's Stortford.
Smith, I. C.	Surveyor to the Rural District Council, Chelmsford.
Smythe, F.	Surveyor to Urban District Council, Finchley, N.
Stallard, S.	Surveyor to Rural District Council, Maidstone.
Stevenson, J.	Surveyor to Urban District Council, East Molesey.
Stickland, E. A., Assoc. M. Inst. C.E.	Borough Surveyor, Newbury.
Stringfellow, H. W.	City Surveyor, Chichester.
Stringfellow, W.	Surveyor to the Urban District Council, East Cowes, Isle of Wight.
Terrill, W.	Surveyor to the Urban District Council, Ashford, Kent.
Thomas, R. J.	County Surveyor, Aylesbury.

Tomes, G. B.	Surveyor to the Barnes District Urban District Council.
Towlson, S.	Surveyor to the Urban District Council, Cheshunt.
Walker, T., M. Inst. C.E. (*Member of Council.*)	Borough Surveyor, Croydon, Surrey.
Waterhouse, D.	Surveyor to the Urban District Council, Watford.
Watts, E. T.	Surveyor to the Rural District Council, Bishop's Stortford.
Weston, H. J., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Shirley and Freemantle, Southampton.
White, J., A. M. Inst. C.E.	Borough Surveyor, Folkestone.
Whitehead, C. L.	Surveyor to Urban District Council, Chesham.
WHITE, W. H., M.Inst.C.E. (*Past President.*)	City Engineer, Oxford.
Winship, G., A. M. Inst. C.E.	Borough Surveyor, Abingdon, Berks.
Woodbridge, C. A.	Surveyor to the Hendon Union Rural District Council.
Worth, J. E., M. Inst. C.E.	District Engineer, London County Council, Spring Gardens, S.W.
York, H.	Surveyor to the Urban District Council, East Barnet Valley.

TOWNS.

Abingdon	G. Winship.
Acton	D. J. Ebbetts.
Alverstoke	W. H. Fry.
Aylesbury	J. H. Bradford.
„ (County)	R. J. Thomas.
Barking	C. J. Dawson.
Barnes	G. B. Tomes.
Beckenham	J. A. Angell.
Bedford	J. Lund.
„ (County)	W. H. Leete.
Bexhill	M. D. Graves.
Biggleswade	G. W. Manning.
Bishop's Stortford	R. S. Scott.
„ „ (Rural D.C.)	E. T. Watts.
Brighton	F. J. C. May.
Bromley	S. T. Hawkings.
Buckinghamshire (County)	R. J. Thomas.
Canterbury	A. H. Campbell.
Carshalton	T. L. Heward.
Chesham	C. L. Whitehead, jun.
Cheshunt	S. Towlson.
Chichester	H. W. Stringfellow.
Cookham	F. Laurens.
Croydon	T. Walker.
Deal	T. C. Golder.
Dorking	G. S. Mathews.
„ (Rural D.C.)	W. Rapley, jun.
Ealing	C. Jones.
East Barnet Valley	H. York.
East Cowes	W. Stringfellow.

Eastbourne	R. M. Gloyne.
East Ham	W. H. Savage.
East Molesey	J. Stevenson.
Epsom	E. R. Capon.
Erith	H. Hind.
Fareham	W. Butler.
Finchley	F. Smythe.
Folkestone	J. White.
Friern Barnet	E. J. Reynolds.
Guildford	F. T. Maltby.
Hampshire (County)	J. Robinson.
Hampton	J. Kemp.
Hanwell	S. W. J. Barnes.
Harrow	T. Charles.
Hendon	S. S. Grimley.
„ (Rural)	C. A. Woodbridge.
Henley-on-Thames	R. Pratt.
Heston and Isleworth	W. A. Davies.
High Wycombe	T. J. Rushbrooke.
Hornsey	E. J. Lovegrove.
Hove	H. H. Scott.
Kent (County)	F. W. Ruck.
Kingston (Highway Board)	A. J. Henderson.
„ (Rural)	W. H. Hope.
Lewes	T. W. Franks.
Leyton, E.	W. Dawson.
Littlehampton	H. Howard.
London (County)	A. R. Binnie.
„ „	J. E. Worth.
Lymington	C. A. Bridges.
Maidstone (Rural)	S. Stallard.
Malton	R. Richardson.
Margate	A. Latham.
Milton-next-Sittingbourne	A. B. Acworth.
New Barnet	G. W. Brumell.
Newbury	E. A. Stickland.
Oxford	W. H. White.
Portsmouth	P. Murch.
Ramsgate	W. Oxtoby.
Reigate	F. D. Clark.
Richmond	J. H. Brierley.
Rochester	W. Banks.
Ryde	F. Newman.
Sandwich	A. J. Catt.
Sevenoaks	J. Mann.
Sheerness	C. A. Copland.
Shirley and Freemantle	H. J. Weston.
Slough	J. Baker.
Southampton	W. B. G. Bennett.
Southend-on-Sea	C. T. Copley.
Southgate	C. G. Lawson.
South Hornsey	M. W. Jameson.

Surrey (County)	F. G. Howell.
Sussex (County), East	Hy. Card.
„ „ West	C. Adcock.
Sutton	A. D. Greatorex.
Tonbridge	A. F. Ginn
Tunbridge Wells	T. E. W. Mellor.
Twickenham	G. B. Laffan.
Ventnor	E. J. Harvey.
Walthamstow	G. W. Holmes.
Wanstead	J. T. Bressey.
Wantage	W. Hanson.
Watford	D. Waterhouse.
„ (Rural)	G. A. Heath.
West Cowes	N. F. Dennis.
West Ham, London	L. Angell.
Willesden	O. C. Robson.
Wimbledon	C. H. Cooper.
Woodford	C. Mathew.
Wood Green	C. J. Gunyon.
Worthing	M. Aspinall.

No. 2.—METROPOLITAN DISTRICT.

Hon. Secretary—G. R. W. Wheeler, Town Hall, Westminster, S.W.

MEMBERS.

Barber, Jas.	Late Surveyor to the Parishes of Streatham and Tooting. Endlesham Road, Balham, S.W.
Barber, J. P., A.M.Inst.C.E.	Vestry Surveyor, St. Mary, Islington.
Barratt, F. W.	Vestry Surveyor, Bethnal Green.
Blair, W. N., A.M.Inst.C.E.	Vestry Surveyor, St. Pancras.
Botterill, C.	Vestry Surveyor, Town Hall, Walham Green.
Burgess, S. E.	Vestry Surveyor, Stoke Newington.
Carline, J., A. M. Inst. C.E.	District Surveyor, Lewisham, Catford Hill, S.E.
Dodd, P., Assoc. M. Inst. C.E.	Surveyor, Wandsworth, S.W.
Findlay, R., A. M. Inst. C.E.	Surveyor to the Parish of Eltham, Plumstead.
Forder, W. G., A.M.Inst.C.E.	Surveyor to the Rural District Council, Croydon.
Gow, W. C.	Vestry Surveyor, Vestry Hall, Plumstead.
Higgens, T. W. E., Assoc. M. Inst. C.E.	Vestry Surveyor, Chelsea.
Holt, G. F.	Vestry Surveyor, Poplar District Board of Works.
Iron, W.	Vestry Surveyor, Clerkenwell.
Isaacs, L. H.	Surveyor to the Holborn District Board of Works, Verulam Buildings, Gray's Inn Road.
Knight, J. M.	Vestry Surveyor, Vestry Hall, Mile End.

Livingstone, Geo., Assoc. M. Inst. C.E.	Vestry Surveyor, St. George, Hanover Square.
Lowe, C. H., Assoc. M. Inst. C.E. (*Vice-President.*)	Vestry Surveyor, Hampstead.
Mair, H., Assoc. M. Inst. C.E.	Surveyor to the Parish of Hammersmith.
Marten, H. J., A.M.Inst.C.E.	Vestry Surveyor, Wandsworth (Streatham and Tooting).
Mason, C., Assoc. M. Inst. C.E.	Vestry Surveyor, St. Martin-in-the-Fields. Town Hall, Charing Cross, S.W.
Meaby, M. C., A.M.Inst.C.E.	Vestry Surveyor, St. Luke, Middlesex.
Norrington, J. P., Assoc. M. Inst. C.E.	Vestry Surveyor, Kennington Green.
Norrish, G. R.	Vestry Surveyor, St. Saviour, Southwark.
Pilditch, J. T.	Vestry Surveyor, Battersea.
Pritchard, E., M. Inst. C.E. (*Past President*).	1 Victoria Street, Westminster, S.W.
Radford, J. C., A.M.Inst.C.E.	District Surveyor, Putney.
Rowland J.	District Surveyor, Plumstead (Charlton Parish).
Scorgie, N., A.M. Inst. C.E.	Vestry Surveyor, Rotherhithe, S.E.
Southam, A., A.M. Inst. C.E.	Surveyor, Clapham, S.W.
Sumner, F., A.M. Inst. C.E.	Vestry Surveyor, Bermondsey.
Tomkins, H., A.M. Inst. C.E.	Vestry Surveyor, St. Marylebone.
Ventris, A., Assoc. M. Inst. C.E.	Surveyor to the Strand District Board of Works.
Waddington, J. A. P., Assoc. M. Inst. C.E.	Vestry Surveyor, Whitechapel.
Wallace, G.	Surveyor to St. Giles District Board of Works.
Weaver, Wm., M. Inst. C.E. (*Member of Council.*)	Vestry Surveyor, Kensington.
Weston, Geo.	Vestry Surveyor, Paddington.
Wheeler, G. R. W., Assoc. M. Inst. C.E. (*Member of Council.*)	Vestry Surveyor, Westminster. *Hon. Secretary*, Metropolitan District.
Woods, Hy.	District Surveyor, Plumstead (Parishes of Lee and Kidbrook).

TOWNS.

Battersea	J. T. Pilditch.
Bermondsey	F. Sumner.
Bethnal Green	F. W. Barratt.
Charlton	J. Rowland.
Chelsea	T. W. E. Higgens.
Clapham	A. Southam.
Clerkenwell	W. Iron.
Eltham	R. Findlay.
Hammersmith	H. Mair.
Hampstead	C. H. Lowe.
Holborn	L. H. Isaacs.

Kennington Green	J. P. Norrington.
Kensington	W. Weaver.
Lewisham	J. Carline.
Mile End	J. M. Knight.
Paddington	G. Weston.
Plumstead	W. C. Gow.
„	Hy. Woods.
Poplar	G. F. Holt.
Putney	J. C. Radford.
Rotherhithe	N. Scorgie.
St. George, Hanover Square	G. Livingstone.
St. Giles.	G. Wallace.
St. Luke	M. C. Meaby.
St. Martin-in-the-Fields	C. Mason.
St. Mary, Islington	J. P. Barber.
St. Marylebone	H. Tomkins.
St. Pancras	W. N. Blair.
St. Saviour, Southwark	G. R. Norrish.
Strand	A. Ventris.
Streatham and Tooting	H. J. Marten.
Walham Green	G. Botterill.
Wandsworth	P. Dodd.
Westminster	G. R. W. Wheeler.
Whitechapel	J. A. P. Waddington.

No. 3.—THE MIDLAND DISTRICT.

Hon. Secretary—A. T. Davis, Shire Hall, Shrewsbury.

MEMBERS.

Beckley, J. W.	Town Surveyor, Brierley Hill.
Bettany, F.	Borough Engineer, Burslem.
Bishop, McW.	Surveyor to the Urban District Council, Sutton-in-Ashfield, Notts.
Blackshaw, W., A. M. Inst. C.E.	Borough Surveyor, Stafford.
Bradley, J. W.	Borough Engineer, Wolverhampton.
Brettell, W. H.	Surveyor to the Urban District Council, Rowley Regis, Staffordshire.
Brown, Arthur, M.Inst.C.E. (*Member of Council.*)	Borough Engineer, Nottingham.
Brown, W. I.	Borough Surveyor, Northampton.
Brown, W. T.	Surveyor to Rural District Council, Worksop.
Campbell, A. H.	Borough Surveyor, Stratford-on-Avon.
Chipperfield, W. R. H., Assoc. M. Inst. C.E.	Surveyor to the Rural District Council, Atherstone, Warwickshire.
Clarson, H. J.	Borough Surveyor, Tamworth.

Coales, H. G., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Market Harborough.
Comber, A.	Borough Surveyor, Kidderminster.
Cook, F. P., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Mansfield Woodhouse.
Corrie, C. J.	City Surveyor, Lichfield.
Currall, A. E.	Surveyor to the Rural District Council, Solihull, Warwickshire.
Davis, A. T., Assoc. M. Inst. C.E. (*Member of Council.*)	County Surveyor, Salop; *Hon. Secretary*, Midland Counties District.
De Normanville, W., Assoc. M. Inst. C.E.	Borough Surveyor, Leamington Spa.
Dixon, R.	Surveyor to Urban District Council, Harborne.
Dunscombe, N., A.M.I.C.E.	Borough Surveyor, Chesterfield.
EAYRS, J. T., M. Inst. C.E. (*Past President.*)	Borough Surveyor, West Bromwich.
Eddowes, W. C.	Borough Surveyor, Shrewsbury.
Fiddian, W.	Town Surveyor, Stourbridge.
Gammage, J.	Borough Surveyor, Dudley.
Gammell, H. H.	Surveyor to Urban District Council, Perry Barr.
Garratt, C. T.	Surveyor to the Urban District Council, Ashby Woulds.
Garrett, J. H.	County Surveyor, Worcester.
Godfrey, B.	Borough Surveyor, Droitwich.
Godfrey, R., Assoc. M. Inst. C.E. (*Member of Council.*)	Surveyor to the Rural District Council, King's Norton.
Green, A. A.	Borough Surveyor, Brackley.
Griffiths, F.	Corporation Waterworks Engineer, Leicester.
Hamar, A.	Borough Surveyor, Bishop's Castle, Salop.
Hammonds, G. B.	Surveyor to the Urban District Council, Newport, Salop.
Harrison, O. E.	Surveyor to Urban District Council, Worksop.
Harrison, R. J., Assoc. M. Inst. C.E.	Borough Surveyor, Derby.
Hawgood, R. H.	Surveyor to the Rural District Council, Aston.
Hawley, G. W.	Surveyor to the District Highway Board, Nottingham.
Herrod, H.	Surveyor to the Rural District Council, Barrow-on-Soar.
Holland, E. S.	Borough Surveyor, Leominster.
Hooley, E. P., Assoc. M. Inst. C.E. (*Member of Council.*)	County Surveyor, Nottingham.
Jaffrey, W.	Town Surveyor, Matlock Bath.
Jeeves, Ed.	Surveyor to the Urban District Council, Melton Mowbray.
Jukes, W. H.	Surveyor to the Urban District Council, Tipton.
Kennedy, J. D.	Town Surveyor, Retford.
Kilford, H. J.	Borough Surveyor, Ilkeston, Derbyshire.
King, W.	Surveyor to Rural District Council, Blaby.
Law, E.	County Surveyor, Northampton.
Lilley, G. H.	Surveyor to the Urban District Council, Ashby-de-la-Zouch.

LOBLEY, J., M. Inst. C.E. (*Past President.*)	Borough Engineer, Hanley, Staffordshire.
Marston, C. F., Assoc. M. Inst. C.E.	Borough Surveyor, Sutton Coldfield.
Mawbey, E. G., Assoc. M. Inst. C.E.	Borough Engineer, Leicester.
Mawson, R. C.	Borough Surveyor, Evesham.
Middleton, R. H.	Borough Surveyor, Walsall.
Mortimer, J.	Surveyor to the Urban District Council, Tettenhall, near Wolverhampton.
Myatt, J.	Town Surveyor, Leek.
Parker, J., A. M. Inst. C.E.	City Surveyor, Hereford.
Pattison, J., jun.	Borough Surveyor, Newcastle-under-Lyme.
Pemberton, O.	Surveyor to Urban District Council, Desborough.
Pickering, J. S., A. M. Inst. C.E.	Surveyor to Urban District Council, Nuneaton.
PRITCHARD, E., M. Inst. C.E. (*Past President*).	37 Waterloo Street, Birmingham.
Purnell, E. J.	City Surveyor, Coventry, Warwickshire.
Richardson, H., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Aston.
Ridout, A. R.	Surveyor to Urban District Council, Wirksworth.
Scott, E. M.	Borough Surveyor, Wednesbury.
Shackleton, C. W.	Surveyor to the Urban District Council, Coseley.
Sharman, E.	Surveyor to the Urban District Council, Wellingborough, Northamptonshire.
Shaw, J. H.	Surveyor to the Urban District Council, Brownhills, Staffordshire.
Shepherd, G. J.	Highway Surveyor, Kidderminster.
Sheppard, Geo.	Borough Surveyor, Newark.
Simpson, W. H., Assoc. M. Inst. C.E.	Late Surveyor to the Blaby Union Rural District Council, Leicester.
Smith, T. R.	Surveyor to Urban District Council, Kettering.
Smithies, A.	Surveyor to the Urban District Council, West Bridgford.
Story, J. S., M.Inst.C.E. ..	County Surveyor, Derby.
Stuart, J. C.	Surveyor to Urban District Council, Smethwick.
Swindlehurst, J. E., Assoc. M. Inst. C.E.	Borough Surveyor, Burton-upon-Trent.
Thomas, R. J.	County Surveyor, Aylesbury, Bucks.
TILL, W. S., M. Inst. C.E. (*Past President.*)	Borough Engineer, Birmingham.
Tuley, W.	Surveyor to Urban District Council, Rothwell.
Vallance, R. F.	Town Surveyor, Mansfield.
Wakelam, H. T., Assoc. M. Inst. C.E.	County Surveyor, Hereford.
Walshaw, J. W.	Borough Surveyor, Peterborough.
Wardle, J. W., A.M.Inst.C.E.	Borough Surveyor, Longton.
Whitbread, R.	Surveyor to the Urban District Council, Carlton, Notts.
Williams, J. B.	Borough Surveyor, Daventry.
Willmot, J.	County Surveyor, Warwickshire.
Wynne-Roberts, R. O. ..	Borough Surveyor, Oswestry.
Wilson, C. L. N., Assoc. M. Inst. C.E.	Town Surveyor, Bilston.
Wood, A. R.	Surveyor to the Urban District Council, Tunstall.

TOWNS.

Ashby-de-la-Zouch	G. H. Lilley.
Ashby Woulds	C. T. Garratt.
Aston	H. Richardson.
„ (R.D.C.)	R. H. Hawgood.
Atherstone (R.D.C.)	W. R. H. Chipperfield.
Barrow-on-Soar (R.D.C.)	H. Herrod.
Bilston	C. L. N. Wilson.
Birmingham	W. S. Till.
Bishop's Castle	A. Hamar.
Blaby	W. King.
Brackley	A. A. Green.
Brierley Hill	J. W. Beckley.
Brownhills	J. H. Shaw.
Burslem	F. Bettany.
Burton-upon-Trent	J. E. Swindlehurst.
Carlton, Notts.	R. Whitbread.
Chesterfield	N. Dunscombe.
Coseley	C. W. Shackleton.
Coventry	E. J. Purnell.
Daventry	J. B. Williams.
Derby	R. J. Harrison.
„ (County)	J. S. Story.
Desborough	O. Pemberton.
Droitwich	B. Godfrey.
Dudley	J. Gammage.
Hanley	J. Lobley.
Harborne	R. Dixon.
Hereford	J. Parker.
„ (County)	H. T. Wakelam.
Ilkeston	H. J. Kilford.
Kettering	T. R. Smith.
Kidderminster	A. Comber.
„	G. J. Shepherd.
King's Norton (R.D.C.)	R. Godfrey.
Leamington Spa	W. De Normanville.
Leek	J. Myatt.
Leicester	E. G. Mawbey.
Leominster	E. S. Holland.
Lichfield	C. J. Corrie.
Longton	J. W. Wardle.
Mansfield	R. F. Vallance.
Mansfield Woodhouse	F. P. Cook.
Market Harborough	H. G. Coales.
Matlock Bath	W. Jaffrey.
Melton Mowbray	E. Jeeves.
Newark	G. Sheppard.
Newcastle-under-Lyme	J. Pattison, jun.
Newport, Salop	G. B. Hammonds.
Northampton	W. I. Brown.

Northampton (County)	E. Law.
Nottingham	A. Brown.
„ (County)	E. P. Hooley.
Nuneaton	J. S. Pickering.
Oswestry	R. O. W. Roberts.
Oundle	J. M. Siddons.
Perry Barr	H. H. Gammell.
Peterborough	J. W. Walshaw.
Retford	J. D. Kennedy.
Rothwell	W. Tuley.
Rowley Regis	W. H. Brettell.
Rugby	D. G. MacDonald.
Shrewsbury	W. C. Eddowes.
Shropshire (County)	A. T. Davis.
Smethwick	J. C. Stuart.
Solihull (Rural)	A. E. Currall.
Stafford	W. Blackshaw.
Stourbridge	W. Fiddian.
Stratford-on-Avon	A. H. Campbell.
Stretford	H. Royle.
Sutton Coldfield	C. F. Marston.
Sutton-in-Ashfield	McW. Bishop.
Tamworth	H. J. Clarson.
Tettenhall	J. Mortimer.
Tipton	W. H. Jukes.
Tunstall	A. R. Wood.
Walsall	R. H. Middleton.
Warwickshire	J. Willmot.
Wednesbury	E. M. Scott.
Wellingborough	E. Sharman.
West Bromwich, Staffordshire	J. T. Eayrs.
Wolverhampton	R. E. W. Berrington.
Worcester (County)	J. H. Garrett.
Worksop (Rural)	W. T. Brown.

No. 4.—THE YORKSHIRE DISTRICT.

Hon. Secretary—T. W. Stainthorpe, Eston.

MEMBERS.

Armistead, Richard, Assoc. M. Inst. C.E.	Surveyor to the Improvement Commissioners, Bingley, Yorkshire.
Baker, F.	Borough Surveyor, Middlesbrough.
Barras, C. C.	Surveyor to Rural District Council, Doncaster.
Beaumont, A.	County Surveyor, Yorkshire, East Riding.
Brown, R. R.	Surveyor to Urban District Council, Bridlington.
Cox, J. H., M. Inst. C.E. (*Member of Council.*)	Borough Surveyor, Town Hall, Bradford.

Crabtree, W. H. R., Assoc. M. Inst. C.E.	Borough Surveyor, Doncaster.
Creer, A., Assoc.M. Inst.C.E. (*Member of Council.*)	City Surveyor, York.
Dearden, Hy.	Borough Surveyor, Batley.
Dyer, S.	Late Surveyor to the Urban District Council, Bridlington.
ESCOTT, E. R. S., M. Inst. C.E. (*President.*)	Borough Engineer, Halifax.
Fenn, T.	Surveyor to the Urban District Council, Upper Soothill.
Gaskell, P.	Surveyor to the Urban District Council, Hornsea, near Hull.
Hare, F. H.	Surveyor to the Urban District Council, Mirfield.
Hewson, T., M. Inst. C.E. (*Member of Council.*)	Borough Engineer, Leeds.
Hopkinson, W. H.	Borough Engineer, Keighley.
Hopper, H. T.	Surveyor to the Urban District Council, North Ormesby, Middlesbrough.
Horsfall, W. H. D.	Surveyor to Urban District Council, Southowram.
Howcroft, James. (*Member of Council.*)	Surveyor, Kirkleatham Urban District Council, Redcar, Yorkshire; *Hon. Sec.*, Northern Counties District.
Jennings, G.	Borough Surveyor, Rotherham.
Kidd, T., Assoc. M. Inst. C.E.	City Engineer, Ripon.
Lewis, J. D.	City Engineer's Office, Leeds.
Mallinson, T.	Surveyor to the Urban District Council, Skipton.
Marks, H. C., A. M. Inst. C.E.	Borough Engineer, Dewsbury.
Massie, F., Assoc. M. Inst. C.E.	Surveyor to Rural District Council, Wakefield.
Pearson, W. T.	Surveyor to Urban District Council, Rothwell.
Penty, W. G.	Surveyor to the Rural District Council, York.
Petch, J.	Borough Surveyor, Scarborough.
Porter, R.	Borough Surveyor, Wakefield.
Robinson, W. P.	Surveyor to the Urban District Council, Skelton-in-Cleveland.
Ross, P., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, North Bierley, Bradford.
Rothera, F.	Surveyor to the Urban District Council, Sowerby Bridge.
Saville, J.	Town Surveyor, Heckmondwike.
Spinks, W., Assoc. M. Inst. C.E.	52 Prudential Assurance Buildings, Park Row, Leeds.
Stainthorpe, T. W. (*Member of Council.*)	Surveyor to the Eston Urban District Council, Yorkshire; *Hon. Sec.*, Yorkshire District.
Stead, S.	Borough Surveyor, Harrogate.
Sutcliffe, A.	Surveyor to Urban District Council, Featherstone.
Tarbit, T. H.	Surveyor to the Urban District Council, Loftus, Yorks.
Trow, S.	Surveyor to the Urban District Council, Otley.
Wetherill, J. W.	Surveyor to Urban District Council, Rawmarsh.
Wike, C. F., M. Inst. C.E. (*Member of Council.*)	Borough Engineer, Sheffield.

TOWNS.

Batley	Hy. Dearden.
Bingley	R. Armistead.
Bradford	J. H. Cox.
Bridlington	R. R. Brown.
Dewsbury	H. C. Marks.
Doncaster	W. H. R. Crabtree.
„ (Rural)	C. C. Barras.
Eston District	T. W. Stainthorpe.
Evesham	R. C. Mawson.
Featherstone	A. Sutcliffe.
Halifax	E. R. S. Escott.
Harrogate	S. Stead.
Heckmondwike	J. Saville.
Hornsea	P. Gaskell.
Hull	A. E. White.
Keighley	W. H. Hopkinson.
Kirkleatham	J. Howcroft.
Leeds	T. Hewson.
Loftus	T. H. Tarbit.
Middlesbrough	F. Baker.
Mirfield	F. H. Hare.
North Bierley	P. Ross.
North Ormesby	H. T. Hopper.
Otley	S. Trow.
Rawmarsh	J. W. Wetherill.
Ripon	T. Kidd.
Rotherham	G. Jennings.
Rothwell	W. T. Pearson.
Scarborough	J. Petch.
Sheffield	C. F. Wike.
Skelton-in-Cleveland	W. P. Robinson.
Skipton	T. Mallinson.
Southowram	W. H. D. Horsfall.
Sowerby Bridge	F. Rothera.
Todmorden	H. Shaw.
Wakefield	R. Porter.
„ (Rural)	F. Massie.
West Hartlepool	J. W. Brown.
Worksop (R.D.C.)	W. T. Brown.
York	A. Creer.
„ (Rural)	W. G. Penty.
Yorkshire (County), East Riding	A. Beaumont.

No. 5.—THE LANCASHIRE AND CHESHIRE DISTRICT.

Hon. Secretary—F. S. Button, Town Hall, Burnley.

MEMBERS.

Adshead, E. E.	Borough Surveyor, Macclesfield.
Atkinson, J., A. M. Inst. C.E.	Borough Surveyor, Stockport.
BOULNOIS, H. P., M. Inst. C.E. (*Past President.*)	City Engineer, Liverpool.
Bradley, J. W., Assoc. M. Inst. C.E.	Borough Engineer, Nelson.
Brierley, R.	Town Surveyor, Newton-in-Makerfield, Lancashire.
Brockbank, W. Hy.	Borough Surveyor, Bolton.
Brooke, J.	Surveyor to Urban District Council, Northwich.
Broom, G. J. C., M. Inst. C.E.	Borough Engineer, St. Helen's, Lancashire.
Brownridge, C., Assoc. M. Inst. C.E.	Borough Engineer, Birkenhead.
Burslam, R.	Borough Surveyor, Congleton.
Burton, J. H...	Surveyor to the Urban District Council, Audenshaw, Lancashire.
Button, F. S., Assoc. M. Inst. C.E. (*Member of Council.*)	Borough Surveyor, Burnley; *Hon. Secretary*, Lancashire and Cheshire District.
Calvert, W.	Surveyor to the Urban District Council, Hebden Bridge.
CARTWRIGHT, J., M. Inst. C.E. (*Past President.*)	Borough Surveyor, Bury, Lancashire.
Clough, W.	Surveyor to Urban District Council, Atherton.
Cook, J., Assoc. M. Inst. C.E.	Borough Surveyor, Lancaster.
Crabtree, W., M. Inst. C.E.	Borough Surveyor, Southport.
Crowther, J. A.	Borough Surveyor, Bootle, Lancashire.
Dent, William	Late Surveyor to the Urban District Council, Nelson-in-Marsden, Lancashire. Railway Street, Nelson.
Diggle, Jas., A. M. Inst. C.E.	Borough Engineer, Heywood.
Diggle, Wm.	Surveyor, Frodsham, Chester.
Dixon, F. E., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Bamber Bridge, near Preston.
Earnshaw, J. T., Assoc. M. Inst. C.E.	Borough Surveyor, Ashton-under-Lyne, Lancashire.
Eaton-Shore, G., Assoc. M. Inst. C.E.	Borough Surveyor, Crewe.
Eckersley, W.	Surveyor to the Urban District Council, Chadderton, Lancashire.
Edmundson, S.	Surveyor to Rural District Council, Burnley.
Entwisle, H.	Surveyor to the Urban District Council, Swinton.
Everett, F. C., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, West Derby.
Foster, T.	Surveyor to the Hoylake and West Kirby Urban District Council.

FOWLER, ALFRED M., M. Inst. C.E. (*President*).	1 St. Peter's Square, Manchester, 35 Old Queen Street, Westminster, S.W.
Fraser, A. O.	Surveyor to the Urban District Council, Allerton, Liverpool.
Gaulter, M. S.	Town Surveyor, Fleetwood.
Goldsworth, W.	Surveyor to the Urban District Council, Prescot, Lancashire.
Greenwood, A.	Late Surveyor to the Urban District Council, Todmorden.
Gregson, J., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Padiham, near Burnley.
Hall, W., Assoc.M.Inst.C.E.	Surveyor to Urban District Council, Great Crosby.
Heaton, Geo., Assoc. M. Inst. C.E.	Surveyor to Urban District Councils, Pemberton, Aspull, Abram, and Orrell. King Street, Wigan.
Higginson, T.	28 Deacon Road, Appleton, Widnes.
Hooley, Cosmo C., Assoc. M. Inst. C.E.	Rural District Council, Barton-upon-Irwell, Patricroft; Urban District Council, Urmston, near Manchester.
Jephson, J.	Surveyor to Urban District Council, Levenshulme.
Jones, I. M., Assoc. M. Inst. C.E.	City Surveyor, Chester; Engineer to the Dee Bridge Commissioners.
Kay, W. R.	Surveyor to the Urban District Council, Irlam.
Landless, J. T.	Surveyor to the Urban District Council, Brierfield, Lancashire.
Leigh, W.	Borough Surveyor, Chorley.
Mawson, Jno.	Late Surveyor to the Urban District Council, Shaw, near Oldham.
McBeath, A. G., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Sale, Cheshire.
MEADE, T. DE COURCY, M.Inst.C.E. (*Past President.*)	City Surveyor, Manchester.
Middlebrook, S.	Surveyor to the Urban District Council, Walton-on-the-Hill.
Mills, J. H.	Surveyor to the Urban District Council, Crompton, near Oldham.
Mitchell, J.	Borough Surveyor, Hyde, Manchester.
Mountain, A. H., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Withington, near Manchester.
Naylor, W., Assoc. M. Inst. C.E.	16 Walton's Parade, Preston.
Newton, G. H.	Surveyor to the Urban District Council, Denton, Manchester.
Newton J., M. Inst. C.E.	Engineer to the Urban District Council, Bowdon, Cheshire.
Newton W. J., A.M.Inst.C.E.	Borough Surveyor, Accrington.
Nuttall, T., Assoc. M. Inst. C.E.	Surveyor to the Urban District Councils, Kearsley and Ramsbottom, Lancashire.
Parkinson, Jas., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Turton, near Bolton.
Platt, S. S., Assoc. M. Inst. C.E. (*Member of Council.*)	Borough Surveyor, Rochdale.
Price, John, Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Toxteth Park, Liverpool.

Proctor, J., M. Inst. C.E.	13 Mawdesley Street, Bolton, Lancashire.
Rothwell, E., Assoc. M. Inst. C.E.	Springfield Cottage, Marland, Rochdale.
Royle, H., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Stretford, Lancashire.
Salmon, A., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Wallasey, Cheshire.
Shaw, H., Assoc. M. Inst. C.E.	Surveyor to Urban District Council, Todmorden.
Sheard, W. C.	Surveyor to the Urban District Council, Heaton Norris.
Sinclair, J. S., A.M.Inst.C.E.	Borough Surveyor, Widnes.
Smith, C. C.	Surveyor to the Urban District Council, Dalton-in-Furness.
Smith, J. B.	Surveyor to Urban District Council, Tyldesley.
Spinks, W., Assoc. M. Inst. C.E.	Late Surveyor to the Urban District Council, Dukinfield. 9 Albert Square, Manchester.
Stokoe, J.	Surveyor to Urban District Council, Altrincham.
Stubbs, Wm., A. M. Inst. C.E.	Borough Surveyor, Darwen.
Swarbrick, Joseph, Assoc. M. Inst. C.E.	44 Brasenose Street, Albert Square, Manchester.
Sykes, Ed., Assoc. M. Inst. C.E.	Late Surveyor to the Urban District Council, Cheadle, Manchester.
Thorburn, T. C.	Late Borough Surveyor, Birkenhead.
Thorpe, Jas.	Surveyor to Rural District Council, Macclesfield.
Travers, W. H.	Surveyor to Urban District Council, Wavertree.
Turley, A. C.	Borough Engineer, Eccles.
Veevers, H., A. M. Inst. C.E.	Surveyor to Urban District Council, Dukinfield.
Watts, W.	Water Engineer, Oldham.
Webster, R. J.	Surveyor to Urban District Council, Castleton
Welburn, W.	Borough Surveyor, Middleton, near Manchester.
Wild, G. H.	Surveyor to Urban District Council, Littleborough, near Manchester.
Wilkinson, J. P., Assoc. M. Inst. C.E.	Assheton Road, Clayton Bridge, Manchester.
Wilson, J.	Borough Surveyor, Bacup, Lancashire.
Window, E. R., Assoc. M. Inst. C.E.	Late Surveyor to the Urban District Council, Bishop's Stortford. 16 Cook Street, Liverpool.
Yates, F. S., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Waterloo, near Liverpool.

TOWNS.

Abram	Geo. Heaton.
Accrington	W. J. Newton.
Allerton	A. O. Fraser.
Altrincham	J. Stokoe.
Ashton-under-Lyne	J. T. Earnshaw.
Aspull	Geo. Heaton.
Atherton	W. Clough.
Audenshaw	J. H. Burton.
Bacup	J. Wilson.
Bamber Bridge	F. E. Dixon.
Barton-upon-Irwell (Rural)	C. C. Hooley.
Birkenhead	C. Brownridge.

Bolton	W. H. Brockbank.
Bootle	J. A. Crowther.
Bowdon	J. Newton.
Brierfield	J. T. Landless.
Burnley	F. S. Button.
„ (Rural)	S Edmondson.
Bury	J. Cartwright.
Castleton	R. J. Webster.
Chadderton	W. Eckersley.
Chester	I. M. Jones.
Chorley	W. Leigh.
Colne	J. Mallinson.
Congleton	R. Burslam.
Crewe	G. Eaton-Shore.
Crompton	J. H. Mills.
Dalton-in-Furness	C. C. Smith.
Darwen	W. Stubbs.
Denton	G. H. Newton.
Dukinfield	H. Veevers.
Eccles	A. C. Turley.
Fleetwood	M. S. Gaulter.
Frodsham	W. Diggle.
Great Crosby	W. Hall.
Heaton Norris	W. C. Sheard.
Hebden Bridge	W. Calvert.
Heywood	J. Diggle.
Hoylake and West Kirby	T. Foster.
Hyde	J. Mitchell.
Irlam	W. R. Kay.
Kearsley	T. Nuttall.
Lancaster	J. Cook.
Levenshulme	J. Jephson.
Littleborough	G. H. Wild.
Liverpool	H. P. Boulnois.
Macclesfield	E. E. Adshead.
„ (Rural)	J. Thorpe.
Manchester	T. de C. Meade.
Middleton, Lancashire	W. Welburn.
Nelson	J. W. Bradley.
Newton-in-Makerfield	R. Brierley.
Northwich	J. Brooke.
Oldham	W. Watts.
Orrell	Geo. Heaton.
Padiham	J. Gregson.
Pemberton	Geo. Heaton.
Prescot	W. Goldsworth.
Ramsbottom	T. Nuttall.
Rochdale	S. S. Platt.

Sale	A. G. McBeath.
Southport	W. Crabtree.
Stockport	J. Atkinson.
St. Helen's	G. J. C. Broom.
Swinton	H. Entwisle.
Toxteth Park	J. Price.
Turton	Jas. Parkinson.
Tyldesley	J. B. Smith.
Wallasey	A. Salmon.
Walton-on-the-Hill	S. Middlebrook.
Waterloo, Liverpool	F. S. Yates.
Wavertree	W. H. Travers.
West Derby	F. C. Everett.
Widnes	J. S. Sinclair.
Withington	A. H. Mountain.

No. 6.—THE WESTERN DISTRICT.

Hon. Secretary—Joseph Hall, Town Hall, Cheltenham.

MEMBERS.

Armytage, W. K. L.	Borough Surveyor, Yeovil.
ASHMEAD, F., M. Inst. C.E. (*Past President*).	"Glenthorn," Alma Vale Road, Clifton, Bristol.
Bayley, W. T. S., Assoc. M. Inst. C.E.	Surveyor to Urban District Council, Warminster.
Beswick, W. H.	Surveyor to Urban District Council, Exmouth.
Caink, T., Assoc. M. Inst. C.E.	City Engineer, Worcester.
Cameron, D.	City Surveyor, Exeter.
Cotterell, A. P. I., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Horfield.
Edinger, P.	Surveyor to the Urban District Council, Frome.
Elford, J.	Borough Surveyor, Poole.
Farrall, T.	Surveyor to the Urban District Council, Sherborne, Dorset.
Flower, J. Moss	Surveyor to the Urban District Council, Portishead, near Bristol.
Garrett, H., A. M. Inst. C.E.	Town Surveyor, Torquay.
Geen, H.	Borough Surveyor, Okehampton.
Gray, W. H.	Borough Surveyor, Tewkesbury, Gloucestershire.
Greenwell, A.	Surveyor to the Rural District Council, Frome.
Hall, Joseph, Assoc. M. Inst. C.E. (*Member of Council.*)	Borough Surveyor, Cheltenham; *Hon. Secretary*, Western Counties District.
Hawkins, I. T.	Town Surveyor, Somerton, Somersetshire.
Haynes, R. H.	Borough Engineer, Newport, Mon.
Hickes, T. J.	County Surveyor, Cornwall (Western division), Truro.

Hodge, J. L., Assoc. M. Inst. C.E.	Late Surveyor to the Urban District Council, East Stonehouse, Devon.
Hunt, G. J.	Borough Surveyor, Dorchester.
Inglis, J. C., M. Inst. C.E.	Surveyor to the Urban District Council, Compton Gifford, Devon.
Jones, C.	Surveyor to Urban District Council, Teignmouth.
Kirby, C., Assoc. M. Inst. C.E.	Water Engineer, Newport, Mon.
Knowles, G. W.	Town Surveyor, Clevedon, Somerset.
Lewis, T. L.	Town Surveyor, St. George, Bristol.
Morgan, W. B., Assoc. M. Inst. C.E.	Borough Surveyor, Weymouth, and Melcombe Regis, Dorchester.
Nettleton, H., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Weston-super-Mare.
Parr, F.	Borough Surveyor, Bridgwater.
Paton, J.	Borough Engineer, Plymouth.
Phillips, R.	County Surveyor, Gloucester.
Powell, D. H. W.	Surveyor to the Urban District Council, Kingswood, near Bristol.
Press, W. J.	Surveyor to the Urban District Council, Burnham, Somerset.
Prouse, O. M., A.M.Inst.C.E.	Surveyor to Urban District Council, Ilfracombe.
Read, Richard, Assoc. M. Inst. C.E.	City Surveyor, Gloucester.
Sadler, G. W.	Late Surveyor to the Rural District Council, 467 High Street, Cheltenham.
Saise, A. J.	Surveyor to the Urban District Council, Stapleton, Bristol.
Stevens, George	Surveyor to Urban District Council, Blaina, Mon.
Stevens, L.	Surveyor to the Urban District Council, Newton Abbott, Devon.
Stringfellow, W., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, East Stonehouse.
Tanner, W.	County Surveyor, Monmouthshire. Newport.
Webster, J. L.	Surveyor to the Urban District Council, Portland.
Widdowson, W. C.	Surveyor to Urban District Council, Tredegar, Mon.
Wyatt, W. J.	Surveyor to the Urban District Council, Paignton, Devon.
Yabbicom, T. H.	Borough Surveyor, Bristol.

TOWNS.

Abergavenny	Jon. Haigh.
Blaina	G. Stevens.
Bournemouth	F. W. Lacey.
Bridgwater	F. Parr.
Bristol	T. H. Yabbicom.
Burnham, Somerset	W. J. Press.

Cheltenham	Jos. Hall.
Compton Gifford	J. C. Inglis.
Cornwall (County), West	T. J. Hickes.
Dorchester	G. J. Hunt.
East Stonehouse	W. Stringfellow.
Exeter	D. Cameron.
Exmouth	W. H. Beswick.
Frome	P. Edinger.
„ (Rural)	A. Greenwell.
Gloucester	R. Read.
„ (County)	R. Phillips.
Horfield	A. P. I. Cotterell.
Ilfracombe	O. M. Prouse.
Kingswood	D. H. W. Powell.
Monmouthshire (County)	W. Tanner.
Newton Abbott	L. Stevens.
Newport, Mon.	R. H. Haynes.
Okehampton	H. Geen.
Paignton	W. J. Wyatt.
Plymouth	J. Paton.
Poole	J. Elford.
Portishead	J. Moss Flower.
Portland	J. L. Webster.
Sherborne	T. Farrall.
Somerton	I. T. Hawkins.
St. George, Bristol	T. L. Lewis.
Teignmouth	C. Jones.
Tewkesbury, Gloucestershire	W. H. Gray.
Torquay	H. A. Garrett.
Tredegar	W. C. Widdowson.
Warminster	W. Bayley.
Weston-super-Mare	H. Nettleton.
Weymouth and Melcombe Regis	W. B. Morgan.
Worcester	T. Caink.
Yeovil	W. K. L. Armytage.

No. 7.—THE NORTHERN DISTRICT.

Hon. Secretary—Jas. Howcroft, Redcar.

MEMBERS.

Anderson, R. S., Assoc. M. Inst. C.E.	County Surveyor, Peebles, N.B.
Beatson, W.	Borough Surveyor, Leith.
Bower, Jas.	Borough Engineer, Gateshead-on-Tyne.
Brodie, J. S., A. M. Inst. C.E.	Town Surveyor, Whitehaven.
Brown, Jos. W., A.M.Inst.C.E.	Borough Engineer, West Hartlepool.
Campbell, K. F., Assoc. M. Inst. C.E.	Borough Surveyor, Stockton.
Cooper, J., Assoc.M.Inst.C.E.	Burgh Engineer, Edinburgh.
Cooper, W. W.	Surveyor to Urban District Council, Bedlington.
Crummack, H. C., Assoc. M. Inst. C.E.	Borough Surveyor, Hartlepool.
Dalton, J. P.	Surveyor to the Urban District Council, Ryton-on-Tyne.
Dickenson, R.	Borough Surveyor, Berwick-on-Tweed.
Dyack, W., Assoc.M.Inst.C.E.	Burgh Surveyor, Aberdeen.
Gregson, G.	Surveyor to the Rural District Council, Durham.
Grieves, R.	Surveyor to the Cowpen Urban District Council, Blyth.
Hall, M.	Borough Surveyor, South Shields, Durham.
Hodgson, W.	Surveyor to the Urban District Council, Keswick.
Hollings, G.	Surveyor to the Urban District Council, Wallsend.
LAWS, W. G., M. Inst. C.E. (*Past President.*)	City Engineer, Newcastle-on-Tyne.
Marsh, R. S.	Surveyor to Urban District Council, Cockermouth.
Mason, W. A.	Surveyor to the Urban District Council, Shildon, near Darlington.
Pattison, W. P.	Surveyor to the Urban District Council, Benwell.
Petree, J.	Borough Surveyor, Jarrow.
Pickering, Richard	11 Lowther Street, Whitehaven.
Rounthwaite, R. S.	Borough Engineer, Sunderland.
Simpson, W. S.	Town Surveyor, Blaydon-on-Tyne.
Smith, W. Howard, Assoc. M. Inst. C E.	City Engineer, Carlisle.
Smillie, J. F.	Borough Surveyor, Tynemouth.
Spencer, J. P., Assoc. M. Inst. C.E.	32 Moseley Street, Newcastle-on-Tyne.
Taylor, H. W.	Surveyor to Urban District Council, Newburn-on-Tyne.
Turnbull, A. J.	Borough Engineer, Greenock.
Watson, J. D. A.M.Inst.C.E.	County Sanitary Engineer, Aberdeenshire.
Waye, H.	Surveyor to the Urban District Council, Millom, Cumberland.
Wilson, Geoffrey	Surveyor to the Urban District Council, Alnwick.
Wilson, J. B.	Surveyor to the Rural District Council, Cockermouth.

TOWNS.

ABERDEEN	W. Dyack.
ABERDEENSHIRE	J. D. Watson.
ALNWICK	G. Wilson.
AYRSHIRE	A. Stevenson.
BEDLINGTON	W. W. Cooper.
BLAYDON-ON-TYNE	W. S. Simpson.
BERWICK-ON-TWEED	R. Dickenson.
BENWELL	W. P. Pattison.
CARLISLE	W. H. Smith.
COCKERMOUTH	R. S. Marsh.
,, (R.D.C.)	J. B. Wilson.
COWPEN	W. Grieves.
DURHAM (R.D.C.)	G. Gregson.
EDINBURGH	J. Cooper.
GATESHEAD-ON-TYNE	J. Bower.
GREENOCK	A. J. Turnbull.
HARTLEPOOL	H. C. Crummack.
JARROW	J. Petree.
KESWICK	W. Hodgson.
LEITH	W. Beatson.
MILLOM	H. Waye.
NEWBURN-ON-TYNE	H. W. Taylor.
NEWCASTLE-ON-TYNE	W. G. Laws.
PEEBLES	R. S. Anderson.
RYTON-ON-TYNE	J. P. Dalton.
SHILDON	W. A. Mason.
SOUTH SHIELDS	M. Hall.
STAPLETON	A. J. Saise.
STOCKTON	K. P. Campbell.
SUNDERLAND	R. S. Rounthwaite.
TYNEMOUTH	J. F. Smillie.
WALLSEND	G. Hollings.
WHITEHAVEN	J. S. Brodie.

No. 8.—THE EASTERN DISTRICT.

Hon. Secretary—J. W. Cockrill, Great Yarmouth.

MEMBERS.

Bland, D.	Surveyor to the Urban District Council, Chesterton, Cambridge.
Buckham, E., M. Inst. C.E. (*Member of Council.*)	Borough Surveyor, Ipswich.
Clare, J.	Surveyor to the Urban District Council, Sleaford.
Cockrill, J. W., Assoc.M.Inst. C.E. (*Member of Council.*)	Borough Surveyor, Great Yarmouth; *Hon. Secretary*, Eastern Counties District.
Cockrill, T., A. M. Inst. C.E.	Surveyor to Urban District Council, Haverhill, Suffolk.
Collins, A. E., A.M.Inst.C.E.	City Engineer, Norwich.
Evans, J.	Borough Surveyor, Grantham.
Goodyear, H., A. M.Inst.C.E.	Borough Surveyor, Colchester.
Hamby, G. H.	Borough Engineer, Lowestoft.
Horton, G. S.	Surveyor to Urban District Council, Felixstowe.
Himson, H. G.	Surveyor to the Urban District Council, East Dereham.
Jevons, J. H.	Surveyor to the Local Board, Braintree.
Keywood, H. G.	Surveyor to Rural District Council, Maldon.
Lacey, G. W.	Borough Surveyor, Saffron Walden.
MacBrair, R. A., Assoc. M. Inst. C.E.	City Engineer, Lincoln.
Macdonald, D. G., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Gainsborough.
Metcalf, J. W., A.M.Inst.C.E.	Town Surveyor, Newmarket.
Miller, Hy.	County Surveyor, East Suffolk, Ipswich.
Moore, G. J.	City Surveyor, Wisbech.
Petree, M.	Borough Surveyor, Great Grimsby.
Plowright, A. H.	Borough Surveyor, Wisbech, Cambs.
Richardson, Jas.	Surveyor to Urban District Council, Stamford.
Robinson, A. R.	Surveyor to the Urban District Council, Clacton-on-Sea.
Rowland, T.	Borough Engineer, Louth, Lincolnshire.
Rush, J.	Borough Surveyor, Eye, Suffolk.
Sasse, G. H.	Borough Surveyor, Chelmsford.
Scott, A. F.	Surveyor to the Urban District Council, Cromer.
Silcock, E. J., A.M.Inst.C.E.	Borough Surveyor, King's Lynn.
Smith, J. C., A. M. Inst. C.E.	Borough Surveyor, Bury St. Edmunds.
Tooley, H.	Surveyor to Urban District Council, Buckhurst Hill.
White, A. E., A.M. Inst. C.E.	Borough Engineer, Hull.

TOWNS.

Braintree	J. H. Jevons.
Bury St. Edmunds	J. C. Smith.
Chelmsford	G. H. Sasse.
„ (R.D.C.)	I. C. Smith.
Chesterton	D. Bland.
Clacton-on-Sea	A. R. Robinson.
Colchester	H. Goodyear.
Cromer	F. A. Scott.
East Dereham	H. G. Himson.
Eye	J. Rush.
Felixstowe	G. S. Horton.
Grantham, Lincolnshire	J. Evans.
Great Grimsby	M. Petree.
Great Yarmouth	J. W. Cockrill.
Harwich	H. Ditcham.
Haverhill	T. Cockrill.
Ipswich	E. Buckham.
Isle of Ely (County)	G. J. Moore.
King's Lynn	E. J. Silcock.
Lincoln	R. A. MacBrair.
Louth	T. Rowland.
Lowestoft	G. H. Hamby.
Maldon	H. G. Keywood.
Newmarket	J. W. Metcalf.
„	H. W. Taylor.
Norwich	A. E. Collins.
Saffron Walden	G. W. Lacey.
Sleaford	Jesse Clare.
Stamford	Jas. Richardson.
Suffolk (County), East	Hy. Miller.
Suffolk „ West	F. Whitmore.
Wisbech	A. H. Plowright.

No. 9.—THE DISTRICT OF WALES.

Hon. Secretaries (North)—J. W. M. Smith, Town Hall, Wrexham
(South)—W. E. C. Thomas, Neath.

MEMBERS.

Baugh, A. C.	Surveyor to Rural District Council, Wrexham.
Bell, Geo.	Borough Surveyor, Swansea.
Bennett, C. G.	Surveyor to Urban District Council, Oystermouth.
Blackburn, T.	Surveyor to Urban District Council, Barmouth, North Wales.

Cooke, E.	Surveyor to Urban District Council, Abersychan.
Coverley, J. S.	Surveyor to the Urban District Council, Penmaenmawr.
Davies, R.	Borough Surveyor, Brecknock.
Davies, R. W.	Surveyor to Urban District Council, Newtown.
Evans, E. I.	Surveyor to the Urban District Council, Penarth, S. Wales.
Farrington, T. B.	Borough Engineer, Conway.
Fraser, W., A. M. Inst. C.E.	Surveyor to the Rural District Council, Cardiff.
Haigh, Jon., A. M. Inst. C.E.	Town Surveyor, Abergavenny.
Harpur, W., M. Inst. C.E.	Borough Surveyor, Cardiff.
Harvey, T. F., Assoc. M. Inst. C.E.	Engineer to the Urban District Council, Merthyr Tydvil.
Holden, Jas.	Surveyor to the Highway Board, Llandaff.
Howell, J.	Surveyor to Urban District Council, Glyncorrwg.
Jones, J.	Surveyor to the Rural District Council, Merthyr Tydvil.
Jones, J. O.	Borough Surveyor, Pwllheli.
Jones, W.	Surveyor to Urban District Council, Colwyn Bay.
Marks, T. T., Assoc. M. Inst. C.E.	Late Town Surveyor, Llandudno, Carnarvonshire.
Maybury, H. P.	Surveyor to Urban District Council, Festiniog.
Morgan, G. S.	Surveyor to Rural District Council, Llantrissant.
Morgan, J.	Surveyor to the Pontardawe Rural District Council, Swansea.
Pardoe, J. C.	Surveyor to the Barry and Cadoxton Urban District Council.
Smith, J. W. M. (*Member of Council.*)	Borough Surveyor, Wrexham, Denbighshire; *Hon. Secretary*, Wales District (North).
Stephenson, E. P.	Town Surveyor, Llandudno.
Stevens, G.	Surveyor to Urban District Council, Abercarne.
Thomas, John, A.M.Inst.C.E.	Surveyor to Rural District Council, Swansea.
Thomas, T. J., A.M.Inst.C.E.	Surveyor to Urban District Council, Ebbw Vale.
Thomas, W.	Late Surveyor to the Margam Urban District Council, Port-Talbot, S. Wales.
Thomas, W. E. C., A. M. Inst. C.E. (*Member of Council.*)	Surveyor to the Rural District Council, Neath. *Hon. Secretary*, Wales District (South).
Watkeys, G.	Surveyor to the Urban District Council, Llanelly.
Williams, H. D.	Surveyor to the Urban District Council, Ogmore and Garrw.

TOWNS.

Abercarne	G. Stevens.
Abersychan	E. Cooke.
Barmouth	T. Blackburn.
Barry and Cadoxton	J. E. Pardoe.
Brecknock	R. Davies.

CARDIFF	W. Harpur.
„ (Rural)	W. Fraser.
COLWYN BAY	W. Jones.
CONWAY	T. B. Farrington.
EBBW VALE	T. J. Thomas.
GLYNCORRWG	J. Howell.
LLANDAFF	Jas. Holden.
LLANDUDNO	E. P. Stephenson.
LLANELLY	G. Watkeys.
LLANTRISSANT	G. S. Morgan.
MERTHYR TYDVIL	T. F. Harvey.
„ „ (R.D.C.)	J. Jones.
NEATH (R.D.C.)	W. E. C. Thomas.
NEWTOWN	R. W. Davies.
OGMORE AND GARRW	H. D. Williams.
OYSTERMOUTH	C. G. Bennett.
PENARTH	E. I. Evans.
PENMAENMAWR	J. S. Coverley.
PONTARDAWE (Rural)	J. Morgan.
PWLLHELI	J. O. Jones.
SWANSEA	G. Bell.
„ (Rural)	J. Thomas.
WREXHAM	J. W. M. Smith.
„ (Rural)	A. C. Baugh.

No. 10—THE IRISH DISTRICT.

Hon. Secretary—R. H. DORMAN, Armagh.

MEMBERS.

BRETLAND, J. C., M. Inst. C.E.	City Surveyor, Belfast.
BRETT, J. H.	County Surveyor, Co. Antrim, Belfast, Ireland.
BURDEN, A.M., A.M.Inst.C.E.	County Surveyor, Kilkenny.
CHRISTIE, J.	City Electrical Engineer. Londonderry.
COLLEN, W., M.A., B.E., Assoc. M. Inst. C.E.	County Surveyor, Dublin South.
COMBER, P. F., M. Inst. C.E.I.	Town Surveyor, Bray.
COWAN, P. C., M. Inst. C.E.	County Surveyor, Down.
DIXON, E. K., M.E., M. Inst. C.E.	County Surveyor, Castlebar, South Mayo.
DORMAN, R. H., M. Inst. C.E. (*Member of Council.*)	County Surveyor, Armagh; *Hon. Secretary*, Irish District.
DUFFIN, W. E. L., M. Inst. C.E.I.	County Surveyor, Co. Waterford.
GLOVER, E., M.A., B.E., M. Inst. C.E.	County Surveyor, Co. Kildare.

Gray, R. A.	County Surveyor, Dublin.
Gunnis, J. W.	County Surveyor, Co. Longford.
Hackett, E. A., M.E., M. Inst. C.E.	County Surveyor, South Tipperary.
Harty, S., M. Inst. C.E.I.	City Engineer, Dublin.
Heron, J.	County Surveyor, Co. Monaghan.
Horan, J., M.E., M. Inst. C.E.	County Surveyor, Co. Limerick.
Jackson, N.	County Surveyor, Co. Cork (West Riding), Bandon, Co. Cork.
Kirkby, S. A., M.A. (Cantab.)	County Surveyor, Co. Cork. Miramur, Queenstown.
Lynam, P. J.	County Surveyor, Louth. Dundalk, Ireland.
Lyons, A. O., M. Inst. C.E.	County Surveyor, Co. Cork (East).
Moore, J. H.	County Surveyor, Meath.
Moynan, J. O.	County Surveyor, North Tipperary.
Orchard, W. P., B.E.	County Surveyor, Ballina, North Mayo, Ireland.
Ottley, D. G., M. Inst. C.E.	County Surveyor, Co. Leitrim.
Perry, J., M.E., M. Inst. C.E.	County Surveyor, Galway (W. Riding).
Robinson, W. J., Assoc. M. Inst. C.E.	City Surveyor, Londonderry.
Sanders, R. B.	County Surveyor, King's County.
Shillington, H.	Town Surveyor, Lurgan.
Smith, J., A. M. Inst. C.E.	County Surveyor, Co. Galway (East Riding). Ballinasloe.
Somerville, R. N., B.E.	County Surveyor, Cavan, Ireland.
White, H. V., M. Inst. C.E. I.	County Surveyor, Queen's Co. Portarlington.
Willson, F. R. T.	County Surveyor, Co. Fermanagh.

TOWNS.

Antrim (County)	J. H. Brett.
Armagh (County)	R. H. Dorman.
Belfast	J. C. Bretland.
Bray	P. F. Comber.
Castlebar	E. K. Dixon.
Cavan (County)	R. N. Somerville.
Cork (County)	N. Jackson.
” ”	S. A. Kirkby.
” ”	A. O. Lyons.
Down (County)	P. C. Cowan.
Dublin	S. Harty.
” (County)	R. A. Gray.
” ” South division	W. Collen.
Fermanagh (County)	F. R. T. Willson.
Galway (County), E. Riding	J. Smith.
” ” W. Riding	J. Perry.
Kildare (County)	E. Glover.
Kilkenny (County)	A. M. Burden.
King's County	R. B. Sanders.

Leitrim (County)	D. G. Ottley.
Limerick (County)	J. Horan.
Londonderry	W. J. Robinson.
„	J. Christie.
Longford (County)	J. W. Gunnis.
Louth (County)	P. J. Lynam.
Lurgan	H. Shillington.
Meath (County)	J. H. Moore.
Monaghan (County)	J. Heron.
North Mayo (County)	W. P. Orchard.
North Tipperary	J. O. Moynan.
Queen's County	H. V. White.
South Tipperary	E. A. Hackett.
Waterford (County)	W. E. L. Duffin.

No. 11—ABROAD.

Hon. Corresponding Secretary—C. Mayne, Shanghai.

MEMBERS.

Abrahams, C. V.	City Surveyor, Kingston, Jamaica.
Aburrow, C., A. M. Inst. C.E.	Town Engineer, Johannesberg, S.A.
Andrews, G. R.	Waterworks Engineer, Johannesberg.
Bellingham, A. W. H., A.M. Inst. C.E.	Municipal Engineer, Tientsin, China.
Brown, P. H., A.M.Inst.C.E.	District Engineer, Godaveri, Madras.
Cairncross, T. W.	Waterworks Engineer, Cape Town, S.A.
Cooper, F. A., M. Inst. C.E.	Director of Public Works, Hong Kong.
Deverell, T. C., Assoc. M. Inst. C.E.	Melbourne, Victoria.
Ellis, R. E., A. M. Inst. C.E.	Engineer to the Municipality, Madras.
Irving, W. E.	Surveyor to the Municipal Shire of Toowong, near Brisbane, Queensland.
Kirk, Thos., A. M. Inst. C.E.	Brisbane, Queensland.
Mayne, C.	Engineer and Surveyor, Municipal Council, Shanghai; *Hon. Corresponding Sec.*, Eastern Asia.
Murzban, M. C., C.I.E., A.M. Inst. C.E.	Municipal Engineer, Bombay.
Parker, W., A. M. Inst. C.E.	District Engineer, Public Works Department, Chapeltown, Jamaica.
Peirce, R.	Municipal Engineer, Penang, Straits Settlements.
Richards, R. W.	City Surveyor, Sydney, N.S.W.
Ross, J.	Town Engineer, Warrnambool, Australia.
Stirrat, J.	Municipal Engineer, Rangoon.

TOWNS.

Bombay	M. C. Murzban.
Brisbane, Queensland	T. Kirk.
Chapeltown, Jamaica	W. Parker.
Godaveri, Madras	P. H. Brown.
Hong Kong	F. A. Cooper.
Johannesberg	C. Aburrow. G. R. Andrews.
Kingston, Jamaica	C. V. Abrahams.
Madras	R. E. Ellis.
Melbourne	T. C. Deverell.
Penang, Straits Settlements	R. Peirce.
Rangoon	J. Stirrat.
Shanghai, China	C. Mayne.
Sydney (N.S.W.)	R. W. Richards.
Tientsin	A. W. H. Bellingham.
Toowong, Queensland	W. E. Irving.
Warrnambool	J. C. Ross.

GRADUATES.

Angel, R. J.	Assistant Borough Surveyor, Town Hall, Walsall.
Armstrong, J. G. D.	H.M. Office of Works, Hanley.
Atkinson, W.	13 Heidelberg Road, Bradford.
Ball, B., Assoc. M. Inst. C.E.	Middleton, near Manchester.
Ball, C. F., A.M. Inst. C.E.	Borough Engineer's Office, Bristol.
Ball, Geo.	Borough Surveyor's Office, Scarborough.
Ball, J. B.	Great Northern Railway, King's Cross.
Bayley, G. H., A.M.Inst.C.E.	Craybrow, Lymm, Warrington.
Birch, J. E. W.	52 Heigham Road, East Ham, E.
Blizard, J. H., A.M.Inst.C.E.	Lansdowne House, Southampton.
Bradshaw, F. E. G.	Borough Engineer's Office, Brighton.
Bradshaw, H. G.	Assistant Surveyor, Bacup.
Bradshaw, J. B.	R. E. Office, Gravesend.
Brown, R.	Urban District Council Offices, Ealing.
Bryans, J. G.	Assistant Engineer, Buenos Ayres and Pacific Railway, Junin, Argentine.
Bryning, W. G.	County Surveyor's Department, Preston.
Burton, A., jun.	Town Hall, Newport, Mon.
Carter, G. F., A.M.Inst.C.E.	City Engineer's Office, Leeds.
Catchpole, J. H.	27 Avenue Villas, Avenue Road, Finchley, N.
Chasemore, A. E.	"Eberbach," Oxford Road, Putney.
Claypoole, A. H.	City Engineer's Office, York.
Clegg, H.	Burgh Surveyor's Office, Aberdeen.
Coales, H. F.	1 Stokenchurch Street, S.W.
Cross, F. W., A.M. Inst. C.E.	The Bridge, Walsall.
Crow, A.	51 Great Prescot Street, E.
Dixon, J. R.	Borough Surveyor's Office, Walsall.
Dolamore, F.	Borough Engineer's Office, Bournemouth.
Fenton, W. C.	Borough Surveyor's Office, Sheffield.
Finch, A. R., A.M. Inst. C.E.	Town Hall, Kensington.
Finglah, F. J.	Town Hall, Hounslow.
Fitton, G.	Borough Engineer's Office, Reading.
Forbes, A. H.	237 West Green Road, Tottenham.
Franck-Clark, A. H.	Assistant County Surveyor, Rednal, near Birmingham.
Gibbs, L., Assoc. M. Inst. C.E.	Surveyor's Office, P.W.D., Hong Kong.
Glass, S. N.	16 Ravenscroft Road, Chiswick, London.
Gordon, J., A.M. Inst. C.E.	Borough Surveyor's Office, Aberdeen.
Green, W. S.	14 Souldern Street, Watford, Herts.
Greenwood, J. P.	Barry and Cadoxton Urban District Council, Cadoxton, near Cardiff.
Hellawell, O.	Town Hall, Withington, Manchester.
Hendry, J. S.	Town Hall, West Bromwich.
Hills, H. J.	97 Camden Street, Camden Town, N.W.
Houghton, J.	King's Heath, Birmingham.
Hurd, H.	Town Hall, Spa Road, S.E.

Ingham, W.	"Essworthy," Sheepstor, Horrabridge, R.S.O., South Devon.
Jenkins, A. J.	Town Hall, Rochdale.
Julian, Julian	Borough Surveyor's Office, Cambridge.
Killick, W. H.	Borough Surveyor's Office, Southampton.
Lobley, F. J.	Assistant Borough Surveyor, Hanley, Staffordshire.
Lynam, G. T., A. M. Inst. C.E.	Assistant Burgh Surveyor, Aberdeen.
Manley, J.	County Surveyor's Office, Liskeard.
Martin, E. B.	City Engineer's Office, Leeds.
Newton, E. B.	City Surveyor's Office, Carlisle.
Nichols, A. E., A.M.Inst.C.E.	City Engineer's Office, Leeds.
Nickols, F. J.	City Surveyor's Office, Carlisle.
Openshaw, J.	City Surveyor's Office, Sheffield.
Perkins, J.	85 Willows Road, Balsall Heath, Birmingham.
Pickering, S. A.	Borough Surveyor's Office, Burnley.
Pickles, G. H.	Borough Surveyor's Office, Burnley.
Price, A. J.	City Engineer's Office, Worcester.
Pritchard, T., A.M.Inst.C.E.	264 Gresham House, Old Broad Street, E.C.
Putman, W. E., A.M.Inst.C.E.	City Engineer's Office, Leeds.
Roberts, F.	Borough Engineer's Office, Birkenhead.
Saunders, J.	Borough Surveyor's Office, Oldham.
Savage, E. B.	City Engineer's Office, Norwich.
Settle, J. A.	Borough Surveyor's Office, Bolton.
Smith-Saville, R. W., Assoc. M. Inst. C.E.	Borough Surveyor's Office, Burton-on-Trent.
Steele, W. J.	Borough Engineer's Office, West Hartlepool.
Taylor, W. J., A.M.Inst.C.E.	1 Rose Road, Southampton.
Thackeray, F.	43 Richmond Terrace, Darwen.
Veit, L. J.	Urban District Council, Tottenham, N.
Videan, H. N.	Assistant Borough Surveyor, Folkestone.
Ward, F. D., A. M. Inst. C.E.	3 Cobden Street, Welshpool.
Williams, D. S.	Woodland Villa, Mountain Ash.
Wood, J. W.	3 Arthur Terrace, Penrith, Cumberland.
Worrall, F.	Borough Surveyor's Office, Leicester.
Wright, J. A.	Lonsdale Chambers, Baldwin Street, Bristol.
Yarwood, Hy.	Town Hall, Rochdale.
Young, W.	Town Hall, Salford.

PARLIAMENTARY COMMITTEE.

O. C. Robson, *Chairman.*

Lewis Angell (West Ham).
R. Godfrey (King's Norton).
Chas. Jones (Ealing).
C. H. Lowe (Hampstead).
T. Walker (Croydon).
W. Weaver (Kensington).

BYE-LAWS.

MEMBERSHIP.

1. Members, Graduates, and Honorary Members of the existing Association may, upon signing and forwarding to the Secretary a claim according to Form F in the Appendix, become Members, Graduates, or Honorary Members respectively of the Association, without election or payment of entrance fees.

MEMBERS.

2. Candidates for admission as Members must be Civil Engineers or Surveyors holding chief permanent appointments under any Municipal Corporations, County Councils, or Urban or Rural Sanitary Authorities, and Civil Engineers or Surveyors holding other chief permanent appointments under any Public Authority of the like nature within the United Kingdom, or in the Colonies or foreign countries.

GRADUATES.

3. Candidates for admission as Graduates must be successful in obtaining certificates of competency at any examination under the auspices of the Association, and who are not otherwise qualified as Members of the Association; and as such shall be entitled to attend the General and District Meetings, and to take part in the proceedings thereof, and be entitled to a copy of the Minutes of Proceedings, but shall not be entitled to vote. Graduates shall at their request become Members of the Association when qualified according to Bye-law 2.

HONORARY MEMBERS.

4. The Council shall have the power to elect as Honorary Members gentlemen of eminent scientific position or acquirements, who in their opinion are eligible for that position.

5. The Members, Graduates, and Honorary Members shall have notice of and the privilege to attend all Meetings, and be entitled to a copy of the Proceedings of the Association as published.

Entrance Fees and Subscriptions.

6. An Entrance Fee of One Guinea shall be paid by each Member, except Members of the existing Association, who shall pay no Entrance Fee. Each Member shall pay an Annual Subscription of One Guinea.

7. A Graduate shall not be required to pay an Entrance Fee, either on his becoming a Graduate or on his becoming a Member. Each Graduate shall pay an Annual Subscription of Half a Guinea.

8. All Subscriptions shall be payable in advance, and shall become due on the 1st day of May in each year; and Members elected between the 1st day of January and the 1st day of May in each year are required to pay an Entrance Fee on Election, their first Subscription being due on the 1st day of May following their Election.

9. The Council may at their discretion reduce or remit the Annual Subscription, or the Arrears of Annual Subscription, of any Member who shall have been a Subscribing Member of the Association for ten years, and shall have become unable to continue the Annual Subscription provided by these Bye-laws.

10. No Proceedings or Ballot Lists shall be sent to Members or Graduates who are in arrear with their Subscriptions more than twelve months, and whose Subscriptions shall not have been remitted by the Council as hereinbefore provided.

Election of Members and Graduates.

11. A recommendation for admission according to Form A for a Member, and Form B for a Graduate, in the Appendix, shall be forwarded to the Secretary, and by him be laid before the next Meeting of the Council.

The recommendation must be signed by not less than Two Members, who from personal knowledge of such Candidate shall certify that he possesses the necessary qualification. Candidates residing outside England and Wales not known by two Members of this Association, may be proposed by three Corporate Members of the Institution of Civil Engineers. Members who cease to hold their appointments are eligible for re-election by the Council, but will be disqualified from holding any Office.

All Elections of Members and Graduates of the Association shall be made by the Council, and shall be decided by a majority of votes of the Members of the Council present and voting.

12. When the proposed Candidate is elected, the Secretary shall give him notice thereof according to Form C; but his name shall not be added to the List of Members or Graduates of the Association until he shall have paid his Entrance Fee and First Annual Subscription as defined by these Bye-laws.

13. A qualified Graduate desirous of becoming a Member shall forward to the Secretary a recommendation according to Form D in the Appendix, signed by not less than two Members, which shall be laid before the next meeting of the Council for their approval. On their approval being given, the Secretary shall notify the same to the Candidate according to Form E. A Graduate on becoming qualified to be a Member shall cease to be a Graduate.

ELECTION OF PRESIDENT, VICE-PRESIDENTS, AND MEMBERS OF COUNCIL.

14. The Council shall nominate one name for President, six for Vice-Presidents, one for Honorary Secretary, and fifteen for Ordinary Members of Council. In addition to these, each Member of the Association shall be at liberty to nominate one Member for the Council, but in the event of the last named nominations exceeding fifteen, the Council shall reduce them to that number, so as to leave thirty names in all from which to elect the required number of Ordinary Members of Council. Members' nominations must be in the hands of the Secretary on or before the 20th of April in each year. And in case the Members' nominations should not reach fifteen, the Council shall have the power to make up the total number of nominations to twenty. Such list of twenty nominations shall be printed and sent to each Member of the Association not less than fourteen days previous to the Annual Meeting. Each Member shall be entitled to vote for or erase any of such Nominations or substitute other names, subject in all cases to the limits of Clause 25 in the Articles of Association, and return the same within seven days from the date of issue. Such Ballot Papers shall be examined in London by the President, Secretaries, and two Scrutineers appointed at the previous Annual Meeting, or by any two of the aforesaid Members. Any Member canvassing for votes for the office of Member of Council shall be considered ineligible for Election.

Appointment and Duties of Officers.

15. The Treasurer shall hold the uninvested funds of the Association, except the moneys in the hands of the Secretary for current expenses. He shall be appointed by the Members at a General or Special Meeting, and shall hold office at the pleasure of the Council.

16. The Secretary of the Association shall be appointed by the Council, and shall be removable by the Council upon three months' notice from any day. The Secretary, if desirous of resigning his appointment, shall give the same notice. The remuneration of the Secretary shall from time to time be fixed by the Council.

17. It shall be the duty of the Secretary, under the direction of the Council, to conduct the correspondence of the Association; to attend all General and Special Meetings of the Association and of the Council, and of Committees (but not the District Meetings, unless required so to do by the President) ; to take minutes of the proceedings of such meetings; to read the minutes of the preceding meetings, and all communications that he may be ordered to read; to superintend the publication of such papers as the Council may direct; to direct the collection of the subscriptions, and the preparation of the account of expenditure of the funds; and to present all accounts to the Council for inspection and approval, and generally to do all such other matters as usually pertain to the office of Secretary, or as may be prescribed by the Council.

Examinations.

18. Two examinations of Candidates for certificates of competency in Municipal Engineering, Surveying, Building Construction, Sanitary Science, and the Public Health Acts, shall be held annually at such places and at such times as the Council shall appoint.

The Board of Examiners shall be 12 in number, and shall be elected by and be Members of the Council, or such other Members of the Association as shall be leading men in their particular branch of the Engineering profession. Four of such Board shall be selected by the Council to carry out each Examination, who as "Acting Examiners," shall report to the Council the names of those Candidates who have satisfied them of their proficiency.

MISCELLANEOUS.

19. All communications to the meetings shall be the property of the Association, and be published only by the authority of the Council.

20. Seven clear days' notice at least shall be given of every meeting of the Council. Such notice shall specify generally the business to be transacted by the meeting.

21. The Council shall present the yearly accounts to the Members at the Annual General Meeting, after being audited by two auditors, who shall be appointed annually by the Members at their Annual General Meeting.

THE
INCORPORATED ASSOCIATION OF MUNICIPAL AND COUNTY ENGINEERS.

TWENTY-SECOND ANNUAL MEETING.

Halifax, *June* 27, 28 *and* 29, 1895.

The Members assembled in the Town Hall, Halifax, the use of which had been kindly granted by the Mayor and Corporation.

The Mayor of Halifax (Mr. Alderman Booth), opened the proceedings by offering to the Association a very hearty welcome to Halifax.

Mr. C. H. Lowe (Vice-President) thanked the Mayor for the cordial reception given to the Association, and the Mayor and Corporation for the use of the Council Chamber and other rooms in the Town Hall.

The Mayor then vacated the chair, which was taken by Mr. C. H. Lowe, in the unavoidable absence of Mr. A. M. Fowler, the outgoing President.

The Minutes of the Annual Meeting held in London in June 1894 were read, confirmed and signed.

The Secretary then read the Council's Annual Report for the year ending April 30, 1895.

ANNUAL REPORT.

At the last Annual Meeting the Council had the pleasure of reminding the Members that the Association had entered upon its twenty-first year. The year has passed away, and at the close of it a note of congratulation must be offered in recording the satisfactory progress which continues to be made with respect, not only to its increase in numbers, but to its increase in usefulness.

District and other Meetings.

Since the last General Meeting, held in London on June 21, 22 and 23, 1894, the following meetings have been held: at Brussels and Antwerp, on August 18 and 19; at Bushey and Hampstead, on November 3; at Middlesbrough, on November 22; at Westminster, on January 18, 1895; at Stockport, on April 27; at Brighton, on May 4; at Cardiff, on May 11; at Plymouth, on May 17 and 18; and at Thirlmere, on June 15. Of these meetings, that held at Brussels and Antwerp in August is especially noteworthy as being the first foreign meeting held since the formation of the Association. The cordial welcome that was accorded to the Association, and the interesting visits to the various works which were inspected, very favourably impressed all those who were enabled to attend, and the Council consider that the success which attended the first foreign meeting fully justifies further occasional visits abroad when future arrangements can be conveniently made. In connection with the Brussels visit, and in acknowledgment of the marked courtesy shown to the Members by the Bourgmestre, the Collège Échevinal, and M. Putzeys (the city engineer), the Council has forwarded in a suitable form the thanks of the Association, with an earnest hope that the Association may be enabled at some future date to reciprocate the kindness evinced to them by the Belgian authorities.

The Roll of the Association.

During the financial year ending April 30 last, 73 new Members, consisting of 56 ordinary Members and 17 Graduates, have joined the Association. Seven Members have resigned, 14 names have been written off, and the Council record with regret the deaths of Messrs. G. S. Hikeley, of Saltburn, E. D. Latham, of Middlesbrough, J. H. Strachan, of Hounslow, P. Burtchaell, of Kilkenny, and W. Brentnall, of Tunbridge Wells. The number on the roll of the Association at the close of the year was nine Honorary Members, 570 ordinary Members, and 67 Graduates, making a total of 646, or an addition of 47 to the numbers of the preceding year. The Council have transferred Mr. F. E. W. Mellor, Mr. N. Parr and Mr. G. W. Lacey from the class of Graduates to that of Members, these gentlemen having been elected to appointments qualifying them for this office under the articles of association.

THE FINANCES.

The audited Balance Sheet which accompanies the Report shows a balance in hand on April 30 of 235*l*. 14*s*. 4*d*. This, taken in connection with the Statement of Assets and Liabilities, shows that the financial position of the Association continues satisfactory. Steps have been taken for a further investment of a portion of the balance shown at the close of the year, the present invested capital amounting to 300*l*.

EXAMINATIONS.

Since the last report two examinations have been carried out, the first of which was held at Birmingham on October 5 and 6, 1894. On this occasion 18 candidates were examined, of whom 13 satisfied the examiners, and were granted their certificates. The examiners were Messrs. Pritchard, Laws, Fowler and Lobley. The second examination was held on April 5 and 6, 1895, at the Institution of Civil Engineers, Westminster, by kind permission, when 19 candidates were examined, of whom 13 satisfied the examiners and were granted their certificates. The examiners were Messrs. Fowler, Laws, Jones and Eayrs. The next examination will be held in Manchester on October 4 and 5.

THE NEW COUNCIL.

The Ballot Lists having been duly issued, the Scrutineers report the result of the voting as follows:—

President—E. R. S. Escott.

Vice-Presidents—A. R. Binnie, C. H. Lowe and O. C. Robson.

Ordinary Members of Council—F. S. Button, J. H. Cox, A. Creer, A. T. Davis, R. Godfrey, E. P. Hooley, E. G. Mawbey, F. J. C. May, S. S. Platt, T. Walker, W. Weaver and C. F. Wike.

General Honorary Secretary—C. Jones.

Treasurer—L. Angell.

COMBINED DRAINAGE.

By a resolution passed at the last Annual Meeting, this matter was referred to the Council for their consideration. In accordance therewith, the subject has received very careful attention at the hands of the Council and of the Parliamentary Committee. A resolution embodying the views of the Association was forwarded to a meeting of delegates from the London vestries held at the Holborn Town Hall on Monday, January 21, and a copy of the resolution was similarly sent to the London County Council. It was then found that the Municipal Corporations Association was promoting a Bill entitled "A Bill to Amend the Public Health Acts with Respect to Sewers," which to a very large extent fulfilled the objects that this Association had in view. The draft of this Bill was then considered, and certain amendments were suggested and afterwards included. Your Council thereupon sent out a circular to every authority in England, asking them to support the Bill by, in the first case, memorialising the Local Government Board for their support, and, secondly, in securing the interest of the respective Members in Parliament. A second circular was then issued giving a suggested form of memorial to the Local Government Board. The Council have received numerous replies from various authorities signifying their intention to adopt the means suggested to support the Bill. It may be mentioned that every effort has been made by the Parliamentary Committee to watch the progress of the Bill in order to meet possible objections, as it was felt that recent decisions of the Courts with regard to sewers and drains are productive of great inconvenience in practice, and impose great costs on the rates, and that legislation is therefore needed. Your Council, however, regret to state that the Bill has now been withdrawn. They trust, however, that measures may be taken to promote a similar Bill in the future by the Government.

Examinations for Sanitary Inspectors.

In continuation of this subject, referred to in last year's Report, your Council have to state that the joint Committee, under the chairmanship of your representative, Mr. Charles Jones (Past-President), has continued its meetings, the result being that the scheme propounded during the previous year, which was laid before the Local Government Board, has been finally approved and passed, and the necessary proceedings taken for incorporation. It may be added that two Members of the Committee are Nominees of the Local Government Board.

A Corresponding Secretary for the East, &c.

With the idea of extending the usefulness of the Association and creating a bond with our foreign and colonial brethren, your Council have elected Mr. Charles Mayne, Engineer to the Municipal Council, Shanghai, as corresponding Secretary for the East, a step which will doubtless lead to novel and interesting information from abroad, and at the same time be a means of disseminating home practice amongst those engaged upon municipal work in those portions of the British Empire.

Index to Volumes.

Following on the quinquennial rule, which has been heretofore adopted, the Council have issued a complete index of the 20 volumes of *Proceedings*, but instead of incorporating it in the 20 volumes, have issued it as a separate book, believing that it will thus form a handier work of reference.

A New Seal.

It being thought desirable to adopt a new seal for the Association, Members have been requested to furnish sketches for the same, a premium of two guineas being offered for the best design. This has resulted in the receipt of 13 suggestions, which are now under the consideration of the Council for their decision.

Benevolent Fund.

This matter has been again considered by the Council, and referred to a special Committee for consideration and report.

Chas. Jones, *Hon. Sec.*
Thomas Cole, *Secretary.*

The Chairman proposed, and Mr. Savage seconded, the adoption of the Report. Carried unanimously.

A short discussion followed in reference to the advisability of getting the papers printed and circulated before the Meeting. Ultimately the matter was referred to the Council to see if the suggestion was possible.

Mr. Lowe then left the Chair in favour of Mr. E. R. S. Escott.

A vote of thanks to Mr. A. M. Fowler, the retiring President, was proposed by Mr. C. Jones, seconded by Mr. Lowe, and carried unanimously.

Mr. Escott read his inaugural address,* a vote of thanks for which was proposed by Mr. Boulnois, seconded by Mr. Davis, and carried.

It having been moved and seconded, it was agreed that the various District Secretaries continue in office till the next Meeting in their respective districts.

Messrs. T. L. Lewis (St. George's, Bristol) and W. H. Savage (East Ham) were elected Auditors for the ensuing year.

Messrs. S. T. Hawkins (Bromley), J. Mann (Sevenoaks) and E. J. Silcock (King's Lynn) were elected Scrutineers for the ensuing year.

The following papers were then read :—

"Royton Sewage Works." By T. S. McCallum and W. Naylor. "Sewage Farm Management." By Lieut.-Col. A. S. Jones. "Park and Garden Architecture." By T. H. Mawson. "Trade Effluents." By W. Spinks.

A cordial vote of thanks was accorded to the authors of the several papers for their contributions.

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* This Address, and the Papers read at the Meeting, will be found at the end of this volume.

Dr. STATEMENT OF RECEIPTS AND EXPENDITURE FOR THE YEAR ENDING APRIL 30TH, 1895. Cr.

RECEIPTS.

	£	s.	d.
To Balance at Bank, May 1st, 1894	294	10	5
„ Entrance Fees	51	9	0
„ Subscriptions	527	2	0
„ New Graduates	8	8	0
„ Subscriptions in advance	14	3	6
„ Arrears	26	5	0
„ Sale of 'Proceedings'	20	18	3
„ Examination Fees	118	2	6
„ Interest on Stock	10	3	0
	£1,071	1	8

EXPENDITURE.

				£	s.	d.
By Reports of Meetings				32	11	0
„ Scrutineers' Expenses				4	16	6
„ Auditors' Expenses				4	6	10
„ Examiners' Fees and Expenses				65	9	3
„ Secretary's Salary, Office Rent, &c.				200	0	0
„ Printing, Stationery				71	12	11
„ Travelling Expenses				27	11	4
„ Premiums				15	0	0
„ Sprague and Co. (illustrations)				36	3	0
„ Clowes, Vol. XX., Index and other Printing				323	0	10
„ Bank charges				0	13	3
„ Sundries				4	2	5
„ Petty Cash—Postages	37	18	1			
General	12	1	11—	50	0	0
„ Balance at Bank, April 30th, 1894				235	14	4
				£1,071	1	8

STATEMENT OF ASSETS AND LIABILITIES.

LIABILITIES.

	£	s.	d.
To Estimated Liability on Vol. XXI.	40	0	0
„ Sundry Printing	10	0	0
„ Reporting	12	12	0
„ Balance, Petty Cash due to Secretary	0	8	1
„ Balance	671	15	11
	£734	16	0

ASSETS.

				£	s.	d.
By Balance at Bank				235	14	4
„ £300 Southampton Corporation 3½ per cent. Stock				324	0	0
„ Subscriptions in Arrear	73	10	0			
less 50 per cent. bad	36	15	0—	36	15	0
„ 'Proceedings' in Stock	222	13	3			
less 50 per cent.	111	6	8—	111	6	8
„ Office Furniture				27	0	0
				£734	16	0

Examined and found correct,
May 29th, 1895.

R. J. Thomas,
John Parker, } *Auditors.*

Lewis Angell, *Treasurer.* Chas. Jones, *Hon. Sec.*
Thomas Cole, *Secretary.*

MEETING AT BRUSSELS, MALINES AND ANTWERP.

A. M. Fowler, *President.*

1. BRUSSELS—August 17, 1894.

The Members assembled at the Bourse, and under the guidance of Monsieur Putzeys, the City Engineer of Brussels, and M. Jamblinne de Meux, visited the sewage collector, and the electric lighting station in the Rue Sainte Catherine where the party were received by Mr. Stuart A. Russell and the staff of the India-Rubber, Gutta-Percha and Telegraph Works Company. The following is a description of

THE BRUSSELS MUNICIPAL ELECTRIC LIGHT STATION.

The Inception of the Station.

The Municipal Council of Brussels have for several years had under consideration the question of lighting the town by electricity. It was for some time undecided whether to introduce a municipal supply or to grant a concession to a company, but eventually it was resolved to adopt the former course. As a result of this decision, a general specification was prepared in April 1891, and tenders were invited from different quarters for a complete scheme, comprising both public and private illumination. The system to be introduced was not specified, but full details of the proposed method were required, together with particulars of the estimated working expenses. At the same time it was notified that the contractor selected to carry out the enterprise would be required to undertake the working of the station for two years, and would be liable to heavy fines in the event of the actual working expenses during that period exceeding the estimates. The schemes submitted included both alternating and direct current systems, and the municipality selected a three-wire low-pressure distribution method worked in conjunction with accumulators. On December 5, 1892, the India-Rubber, Gutta-Percha and Telegraph Works Company, of Silvertown, England, and Persan-Beaumont, France (represented in Belgium by Mr. Boty), were entrusted with the execution of the contract, on the understanding that, as far as possible, all machinery, &c., should be constructed in Belgium, and that the whole of the contract should be completed in eight months after the site for the station had been placed at their disposal. The site selected for the central station was that occupied by the old church of St. Catherine, Rue Melsens, in the lower part of the town, adjoining the main boulevard, and this ground, with the church and buildings upon it, was handed over to the Company on February 13, 1893. The work of demolition was commenced on the same day, and this, together with the excavating work for foundations—which necessitated the removal of 7000 cubic yards of earth, and the clearing away of the massive foundations of the old church—occupied a period of about ten weeks. Eventually, in the middle of May, the construction of the new buildings was commenced by the contractor, M. La Barre, acting under the instructions of M. Deviaeux, the architect, and of the Company's resident engineer, Mr. Stuart A. Russell.

The Station Buildings.

The buildings include a boiler and machine room on the ground floor, and on the first floor a battery-room, repairing shop and stores over the machine-room, whilst the coal store, water purifiers and tanks are placed over the boiler-room. The chimney, which is 190 feet high and 8 feet 4 inches internal diameter at the top, occupies an angle formed by the boiler and machine rooms, and is built of radial bricks and carried on a brick and concrete foundation 15 feet deep. The offices necessary for the administration and the testing-rooms are arranged in the same block of buildings, but occupying a strip of land separating the station proper from the Rue Melsens. The coal store, which has a capacity of 200 tons, is on the first floor, and an electric lift has been constructed to convey the fuel to it. A small tramway to the Willebroeck canal will be constructed to facilitate the discharge of fuel brought by water. From the coal store the fuel is conveyed by suitable shoots to the stoking space—the shoots being telescopic, so that they may be lowered to avoid the making of dust when coal is being discharged and raised out of the way at other times. The water supply, both for condensation and feed, is obtained from the Willebroeck canal, which is distant about 350 yards. Two 18-inch pipes have been laid down with a slight fall from the canal to a small reservoir under the machine-room, to which are brought the suction pipes of the condenser pumps. A certain quantity of the condensing water according to requirements is pumped up to the water-purifier, from which it is discharged into the main tanks. The water-purifier, which is of the Dervaux type, is capable of dealing with about 2500 gallons of water per hour and the capacity of the main tanks—two in number—is about 22,500 gallons. The station, when complete, will contain plant of 3000 indicated horse-power, the unit adopted being a 500 horse-power engine driving two 250 horse-power dynamos. Provision has been made for laying down six such units, one being a reserve; but as the specification of the municipality stipulated that the machinery should be capable of working at 25 per cent. in excess of its normal full load, the ultimate maximum working capacity of the station may be taken as 3000 horse-power, not including reserve.

The Boiler House.

The present plant consists of three Babcock & Wilcox boilers, constructed by Brouhon, of Liège; each has a heating surface of 2440 square feet and is capable of evaporating 7500 lbs. of water per hour with a good quality of Belgian coal. The boilers are of the usual type, working at 135 lbs. pressure, but having a specially large grate surface (56 square feet) to allow of coke being used for firing instead of coal. The boilers are fed by a Worthington pump, a second being held in reserve. Each pump is capable of supplying to the boilers 2600 gallons of water per hour, the water being drawn from a small cistern at the back of the boilers, to which the water descends from the main tanks, the supply being regulated by a ball-cock. This cistern can also be supplied with water from the town mains in case of an accident preventing the use of the supply from the canal. The feed water passes from the pumps through a Green's economiser, of which two have been provided, each of 2160 square feet heating surface, and thence to the boilers. All the feed piping is doubled, and is so arranged that any boiler can be fed by either pump, the feed water passing through the economiser, or, in case of repairs to this apparatus, directly to the boiler. All the steam piping is also double, two main pipes running across the tops of the boilers being carried through into the machine-room and running in a subway the whole length of it. Each boiler is connected to each of the two main pipes by a branch provided with a stop valve, and a branch is taken from each main pipe to each engine.

The Engine and Dynamo Room.

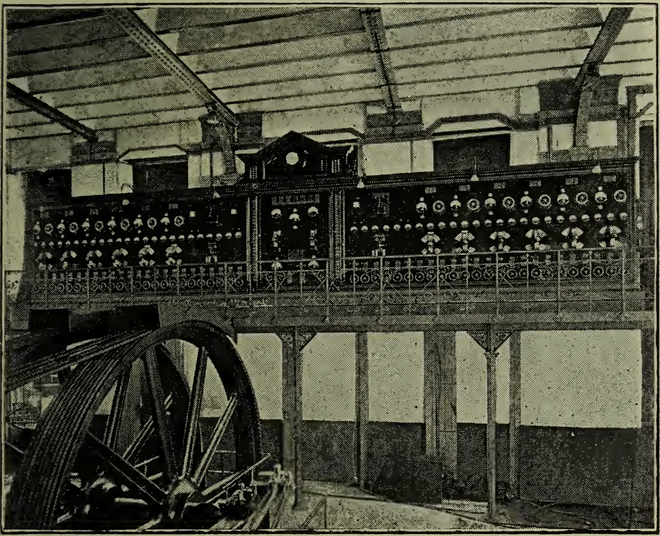
The machine-room, which is 120 feet by 52 feet, and 28 feet high, contains the engines, dynamos and switchboard, and is fitted with an overhead traveller running its whole length and capable of lifting 15 tons. To fulfil the stringent conditions as to the absence of vibration, a block of concrete about 6 feet thick has been laid as a foundation, which extends over the whole surface of the engine-room, but it is entirely independent of and isolated from the foundations of the building. On this block the brickwork foundations—also separated from the walls of the building—for the engines and dynamos have been built. The engines, two in number, are of the Sulzer horizontal side-by-side compound condensing type, having adjustable cut-off, supplied by Carel Frères, of Ghent. The low-pressure cylinders are 40 inches in diameter and the high-pressure cylinders 26 inches in diameter; the length of stroke is 4 feet, and the speed is capable of variation between 62 and 75 revolutions per minute, the higher speed being necessary for the charging of the accumulators. Each engine is fitted with two nine-groove fly driving-wheels 20 feet in diameter and weighing 20 tons. The most economical load for each machine is 400 horse-power, so that for a range of 250 horse-power to 625 horse-power, the consumption of steam per brake horse-power is small, and a good efficiency should be assured on the average working load throughout the year. For engines of a similar type constructed by the same firm, tests carried out by the Association for the Supervision of Boilers give the following results: On an engine constructed for a normal output of 500 horse-power at 60 revolutions, when working at 138 horse-power with 5·7 atmospheres pressure (85 lbs.), the steam consumption on a test of eight hours was rather less than 13 lbs. steam per indicated horse-power hour. With a similar type of engine of 400 horse-power size, working at 5·8 atmospheres (87 lbs.) and indicating 250 horse-power, the steam consumption was 13·1 lbs. The same engine tested five and a-half years later gave a consumption of rather less than 14 lbs. working at 6·9 atmospheres (103½ lbs.) and indicating 330 horse-power. The engines are erected side by side with the cylinders at right angles to the length of the hall, and each engine drives two dynamos by means of eighteen 1⅝-inch ropes. The dynamos are of the four-pole type, shunt wound with drum armature, running at 300 to 360 revolutions per minute, with an output of 145 kilowatts as the normal full load, but capable of working up to 180 kilowatts for a continuous run of twelve hours without overheating or sparking at the brushes. These dynamos are carried on slide rails, to allow of the tightening of the rope drive as required, and are fitted with self-oiling bearings. They have been constructed, as was the switchboard, by the Société Électricité et Hydraulique to designs and plans supplied by the Silvertown Company.

The Dynamo and Switchboard Connections.

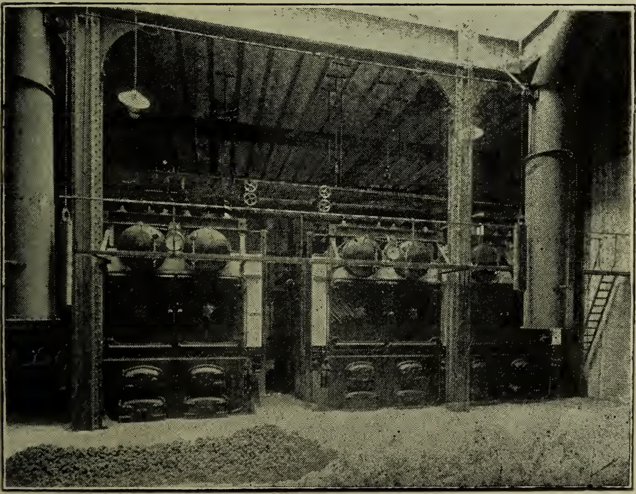
The switchboard is fitted for six pairs of dynamos, a battery of accumulators and twenty-four feeders, and is formed of a series of black marble panels carried in a wrought-iron frame, the whole being mounted on a gallery fixed against one of the long walls of the engine-room, at a height of about 14 feet above the floor. Thus the attendants have an uninterrupted view of all the machines. The general scheme of connection of the switchboard is as follows, each set of connections being the same for each pair of dynamos: The positive pole of No. 1 dynamo is connected permanently to the negative pole of dynamo No. 2, and both are connected through a fusible cut-out to the neutral omnibus bar of the switchboard. The negative pole of No. 1 dynamo is connected through a fusible cut-out and an amperemeter to the fixed terminal of a two-way switch, by means of which the circuit can be made either on to the charging circuit of the accumulators or on to the negative omnibus bar. The positive pole of No. 2 dynamo is connected in the same way to the accumulators or positive omnibus bar. The exciting

BRUSSELS CENTRAL STATION.

PLATE I



GENERAL VIEW OF SWITCHBOARD.



THE BOILER HOUSE.

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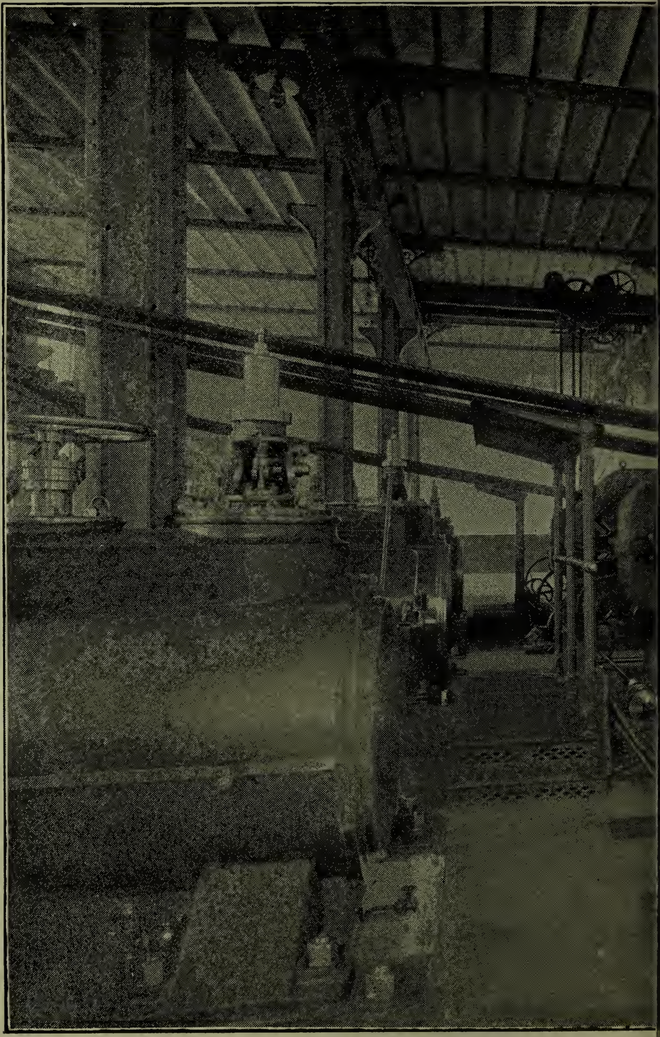
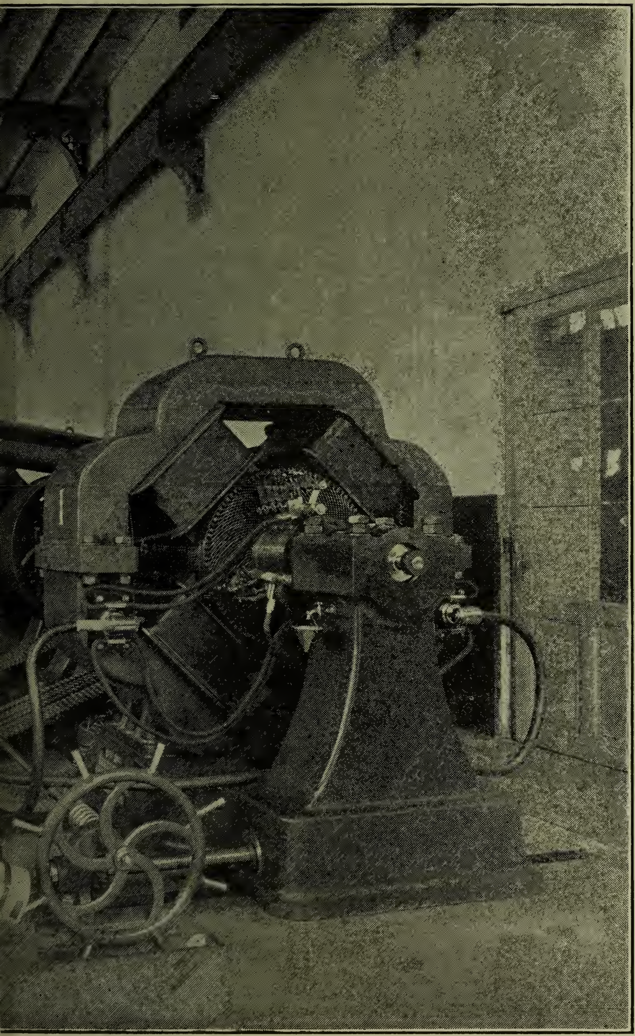


END LINE

RAL STATION.

II.



DYNAMOS.

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circuit of the dynamo is arranged as follows :—The positive terminal of the shunt on dynamo No. 1 and the negative of No. 2 dynamo are permanently connected to the corresponding main dynamo terminals, and therefore to the neutral omnibus bar on the switchboard. The negative terminal of the shunt on dynamo No. 1 is connected to a switch fixed on the dynamo, through which the circuit is connected to the negative omnibus bar, an adjustable resistance fixed on the switchboard being interposed to permit of variation in the exciting current. The positive terminal of No. 2 dynamo is connected in the same way to the positive omnibus bar on the switchboard. The shunt circuit switches on the dynamos are specially arranged to close the circuit of the shunt on that of an auxiliary resistance at the moment of rupture, to diminish the sparking and strains on the insulation caused by the electromotive force due to self-induction on breaking the circuit.

DISTRIBUTION.

For the main feeder circuits, of which there are about twenty-four, each positive feeder is connected through a separate adjustable main resistance and fusible cut-out with the positive omnibus bar, the negative feeder being connected in the same way to the negative omnibus bar, the intermediate feeder being connected directly to the immediate omnibus bar. To each distributing centre is led a three-core potential cable conductor 7/20 L.S.G., connected at one end to the three main cables in the distributing-box at the centre, and at the other end to a pair of voltmeters mounted on the switchboard, to indicate the pressure between the positive feeder and the intermediate, as also between the negative feeder and the intermediate. The pressure is kept constant on each side of the intermediate cable by varying the absorbing resistance in the main feeder circuits. The main resistance is of platinoid strip and fitted with contacts, to allow of separate adjustments of half volt at full load. The centre panels of the switchboard carry the registering ammeters, automatic switches, battery regulators, &c., for connecting up the accumulators. Twenty-six cells at the positive end of the battery, and the same number at the negative end, are connected to regular switches ; and the middle terminal of the battery is connected to the neutral omnibus bar, thus allowing the number of accumulators in use to be varied as required. The discharge side of each regulator is connected through a registering ammeter, a switch and a fusible cut-out to the corresponding omnibus bar, and the charge side of each regulator through a registering ammeter and automatic switch to the battery contact of the two-way dynamo switches. The accumulators are of the Julien type, and comprise 140 cells, forming a double battery of 70 cells. Each cell is capable of giving a normal discharge of 350 amperes for ten hours, and in case of necessity the discharge may for a short time be carried up to 1400 amperes without undue deterioration. The cases are of an alloy of lead and antimony. The plates are widely separated, and ample space is left at the bottom for all material that may become detached during work. The total weight of the battery is 80 tons.

The Mains.

For the three-wire distribution, each cable is drawn into a separate cast-iron pipe, with the exception of the potential cable, which is drawn into the same pipe as the intermediate cable. All the tables are continuously insulated, the joints being vulcanised. The conductors are of high conductivity copper—100 per cent. Matthiessen's standard—tinned, and insulated with vulcanised india-rubber, taped over all, and the whole vulcanised together, then strongly braided flax, and lastly covered with preservative compound. The insulation resistance is 1500 megohms per mile, tested in water at 60 deg. Fah. after twenty-four hours' immersion and one minute's electrification. The whole plant was completed and in working order by October 11th, or two days before the date fixed by the contract. The speed at which the work was executed may be further estimated from the fact that, although the definite plan for the system of mains and their laying was only approved by the middle of June, more than 55 miles of pipe were laid, and 26 miles of cable, including a large quantity of 1-inch and 1¼-inch section conductor, was manufactured in England, delivered and laid before the opening of the station. The work of canalisation was carried out by M. Daubeny, assistant engineer to Mr. Russell. The plant and canalisation have been examined and approved by the experts appointed for that purpose. The station was formally inaugurated by the Bourgmestre and Échevins of Brussels on November 9th, since which time it has been giving a continuous night and day service to the complete satisfaction of the town.

Notwithstanding the rapidity with which the work was carried out, the solid construction of the buildings, and the simple but complete establishment of the station, show that durability and efficiency are in no way sacrificed to speed in completion.

THE USE OF INDIA-RUBBER IN INSULATED CABLES.

It is interesting to note that this is the first large central station worked on the low-tension system in which the method of distribution has been entirely carried out with india-rubber insulated cables. It has hitherto been held that the price of such cable was prohibitory—at least for the larger sizes. This question of prime cost is too often considered at the expense of efficiency, and it certainly appears reasonable that any town having facilities for the borrowing of money at a low rate of interest should not decide only on prime cost, but consider closely the important point of cost of maintenance, since in many cases, if this cost were capitalised, it would be found more economical to incur a heavier initial cost than to adopt any special system merely on account of low prime cost. Although, as stated, this is the first large low-tension station that has adopted such cables throughout, yet the company who have carried out the work have in the last year supplied some considerable quantities of these cables to towns where a low-tension system has been adopted—for instance, at Manchester, Glasgow, Dundee and Paris (where this type is now being largely adopted). For the high-tension system, where hitherto it has been considered that insulation is of more importance than for low-tension, it is understood that this company has supplied, in whole or part, the cables for the following towns, where the results obtained have been invariably satisfactory: London (over 300 miles in use), Paris, Madrid, Brussels, Dublin, Newcastle-on-Tyne, Leeds, Huddersfield, Blackpool, Eastbourne, Hastings, Brighton, Bournemouth, Scarborough, Chelmsford, Burton-on-Trent, Cardiff, Oxford, Cambridge, Woking, Melbourne, Buenos Ayres, Hong-Kong, Tours, Barcelona, Havre, Rouen and Montpellier.

INITIAL COST NOT THE FIRST CONSIDERATION.

These results go far to prove the fallacy of the idea advanced in the earlier days of electric lighting, when it was held by many electrical engineers that no insulation would be found to be durable underground when employed for high-tension alternating current. The reason of the repeated failures was no doubt the too close consideration of prime cost without regard to maintenance; and it remains now to be proved whether the same considerations do not apply to low-tension distributions, and whether the experiments, extending over a number of years, which were carried out by the electricians interested in telegraphy are to be still ignored, on the supposition that the application of electric lighting is on a totally different footing in all respects from underground telegraphy, and that new insulators have now been re-discovered which can adequately replace the lasting, but no doubt costly, vulcanised india-rubber. A sign of the times is that many of the leading cable-manufacturing companies have within the last few years turned their special attention to the manufacture of this type of cable, and if by so doing these cables can be further cheapened without detriment to their efficiency and durability, a great advance will have been made towards the wider adoption of a reliable insulator.

The party then visited the Ferme des Boues, where they were received by M. Smeyers, who showed them the incineration furnaces and the general arrangements for the reception and disposal of refuse. Then at the Rue du Mât the municipal depot was inspected; and here considerable interest was shown in the different types of paving material used for the city—porphyry setts from Quenast and Bierges, sandstone from the Ourthe and the Meuse, granites from Ath, Huppaye and elsewhere, and some particularly noteworthy manufactured setts, as to which a general opinion was expressed that more might be laid with advantage to the city. Minute details were given by M. Putzeys of the relative cost, durability and other qualities of these materials. In the afternoon the gasworks were visited.

THE BRUSSELS GASWORKS.

The first plant for the Brussels gasworks was laid down in 1874–5, under the direction of M. Somzée, and was intended for an annual production of 30,000,000 cubic metres of gas. In 1880 the works comprised four retort houses, having each four sets of eight stacks, with seven large retorts. The carbonising takes four hours; a stack produces 1400 cubic metres of gas per day. Coal was specially obtained from the Borinage (Belgium) and from Newcastle, the furnaces being heated by coke only. Horizontal condensers were disposed along the retort houses for conducting the gas to a group of scrubbers which completed the washing. Now they are directly connected with the vertical condensers.

The purifying house is of great interest. The purifiers are 6 metres* in length by 3 metres in breadth. The heavy covers are lifted and removed by means of rolling cranes worked from a compound machine receiving its steam from a 70 horse-power De Naeyer's boiler. Each apparatus is secured by bye-passes and other connection valves, by which some vessels can be put in operation whilst others are taken out of work for the renewal of the purifying material. This is oxide of iron, no lime being used.

The machine hall comprises two Smitz exhausters, automatically regulated, and one Roerting injector. In summer only one of these machines is in action. Motive power for the exhausters is provided by three Galloway boilers of 20 horse-power.

There are three gasholders of 10,000 cubic metres capacity, and 36 metres diameter, and two of 20,000 cubic metres capacity and 50 metres diameter. The mains are of cast iron, with an india-rubber socket joint formed by passing a vulcanised ring of that material round the spigot end of the pipe. The diameter of the pipes is 0·85 metres where they leave the station, and 0·50 metres in the centre of the town.

Since 1885 the gasworks have been considerably extended, under the direction of M. Aerts, the present manager of the Brussels lighting. Two more gasholders of large capacity have been erected; a new department for oil-gas has been put into work; plans have been prepared for a supplementary purifying house; and various other improvements have been introduced. The capital involved amounts now to about 649,240*l.*, and the working showed an annual profit for 1893–4 of 55,640*l.* The average cost of coal was 18·09 fr. In 1885 the gas sold amounted to 14,644,000 cubic metres. In 1893–4 it amounted to

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* Multiply by 3·3 to convert into feet.

24,645,800 cubic metres, or an increase, notwithstanding the introduction of the Auër system and the electric light, of 738,000 cubic metres over the sales of the preceding year.

The total output during the twelve months was as follows :—

	Cubic metres.
Subscribers' night gas, at 14 centimes	18,623,736
Subscribers' day gas at 10 centimes	3,168,457
Municipal establishments, at 10 centimes	895,475
Motors, at 10 centimes	1,274,278
Industrial purposes, at 10 centimes	382,180
Heating	80,034
Illuminations, &c.	186,234
Various	35,486
Total sale	24,645,880
Public lighting	3,857,912
Gas plant and office	955,492
Loss	978,916
Total production	30,438,200

The length of piping, it may be added, is 164,866 metres. The loss, as will be seen above, is small, amounting, as it does, only to 3·22 per cent.

After leaving the gasworks the engineers inspected the arrangements for the electric tramway service of the Brussels Tramway Company, and were taken over part of the system in a train of cars. M. Albert Bandsept, consulting engineer on lighting and heating works, accompanied the party and courteously afforded information on many points submitted to him. Full particulars of the installation will be found in the following description, which was prepared by M. E. d'Hoop, the electrical engineer to the company.

THE BRUSSELS ELECTRIC TRAMWAYS.

The entire installation has been carried out by the Union Elektricitäts-Gesellschaft of Berlin, who own the concessions for the Thomson-Houston patents. The lines which are worked electrically are those from the Nord to the Midi through the high circular boulevards, and the line from Brussels to Uccle. The central station, which is situated in the Rue Broquier, at present comprises the following plant: three Babcock and Wilcox boilers, each having 235 square metres of heating surface; five compound tandem steam engines by McIntosh and Seymour—diameter of high-pressure cylinder, 13 inches; of low-pressure cylinder, 19 inches; stroke, 15 inches; number of revolutions per minute 235, working pressure 120 lbs., indicated horse-power 180, effective horse-power 150. The exhaust takes place in the atmosphere through a feed-water heater. The feed water, which is previously purified, is obtained from a cistern of 90 cubic metres capacity, and is supplied either from the town mains or from an artesian well. The steam piping is in duplicate, so as to avoid any stoppage. The five dynamos, which are driven direct by belt, are of the Brown tetrapolar type, with drum armature. These dynamos are each of 100 kilowatts (500 volts and 200 amperes) normal output. The armature is toothed (Pacinotti type). The excitation is hyper-compound, regulated so as to allow for a loss of 10 per cent. pressure on the line. The switchboard has as many panels as there are dynamos. Each panel carries, in addition to the switches, an amperemeter, a voltmeter, an exciting rheostat, a current indicator in the balancing wire, and an automatic cut-out which isolates the dynamo when the current reaches a dangerous point.

The Line.

The supply to the cars on the line is effected by two trolley wires of 8 mm. diameter. This trolley wire is fed at intervals of about 500 metres by means of an underground feeder cable which is placed along the line. The section of this cable varies from 316 mm. to 55 mm. It is a Siemens' cable, having a copper core with two lead coverings, and doubly steel armoured. It is placed in the ground on a bed of sand without any protection other than flat bricks, not mortared together, intended to indicate the position of the cable when the street is broken up. The trolley wire is divided into isolated sections each of about 500 metres in length; each section is connected at its two extremities with the feeder cable by means of cables inside the posts, the connecting cables carrying switches, which allow of a section being put out of circuit in case of necessity. On the whole of the way along the boulevards the trolley wire is supported by iron arms fixed on hollow steel posts. In the streets the trolley wire is supported by cross wires of steel attached to the fronts of the houses. The wire is doubly insulated throughout. The rolling stock comprises twenty-three closed cars, having sixteen sitting places and twenty standing places. Each car has two motors of the W.P. type, each of 15 indicated horse-power. This power is sufficient to allow of hauling an open car carrying thirty-six passengers. The cars weigh 5½ tons empty and 8 tons full. A motor car with trailing car weighs, loaded, about 13 tons. The average speed is 12 kilometres per hour, but owing to numerous stoppages, the rate actually reaches at certain points 20 kilometres per hour. The cars are furnished with a series Carslett controller, made by the General Electric Company, United States of America. This apparatus allows of the motors being at will put in series or in parallel, and of varying the intensity of the magnetic field so as to realise four degrees of normal speeds.

The Return, Etc.

The return is formed by the rails. For this purpose the rails, which weigh 30 kilogrammes per metre, are connected at each joint by two pieces of galvanised copper wire of 8 mm. diameter. These wires are fixed to the rails by means of soft steel rivets. In addition, the four sets of rails are connected with each other at distances of about 90 metres. An experimental measurement of the resistance of the return gave a figure sensibly less than the estimated value of this resistance, although the earth connections are of little importance. This arises from the fact that other tramway lines connect the electric lines to the works, and all these lines tend to improve the conditions of the return. The positive pole of the dynamos is connected with the trolley wires, the negative pole with the rails, and at the same time with two pits situated in the works. The telephonic protection consists of a creosoted wooden arrangement placed above the wire. Protection against lightning is obtained by Thomson lightning arresters, with magnetic blower. There are, of these arresters, one on each car, one on each section of the trolley wire, and one on each dynamo at the works. The following are the general particulars of the lines served: Boulevard line—length, 44,650 metres of double line being worked; maximum gradient, 6·2 per cent.; minimum curve, 20 metres. Uccle line—length, 3925 metres; maximum gradient 4·8 in 1500 metres.

The Switching Apparatus.

The switching apparatus on the car consists mainly of two drum commutators, which allow of any desired combination being effected. One of the drums serves simply to reverse the direction of the current in the two armatures for reversing the car. The second allows of the following combinations being obtained:—

1. The two motors in series with all the resistance.
2. „ „ with a part of the resistance.
3. „ „ without resistance.
4. „ „ „ „ with a fraction of the field.
5. The same as the second.
6. One motor only with a part of the resistance.
7. The two motors in parallel with a part of the resistance.
8. „ „ without resistance.
9. „ „ „ „ with a part of the magnetic field only.

The driver is obliged to follow the above order in the various combinations. The combinations 3, 4, 8 and 9 are the only ones used in the course of running. The others are only transition combinations. An accessory apparatus allows of one or other motor at will being thrown out of circuit. A special appliance then prevents any combination beyond the fourth being made.

RECEPTION AT THE HOTEL DE VILLE.

In the evening a brilliant reception was given to the Association at the Hotel de Ville, by the Bourgmestre and the Collège Échevinal. The reception was inaugurated by M. Buls in a cordial welcome delivered in English. The Bourgmestre modestly declared that, though his English guests might not learn anything by their visit, he hoped they would at least carry away with them pleasant recollections of the good feeling shown to them by those with whom they were brought in contact. The President, Mr. A. M. Fowler, acknowledged the hearty greeting, and expressed the unanimous feeling of the Members in assuring the Bourgmestre that they had already found their visit an instructive one, and that they deeply appreciated the kindness and courtesy with which they had been afforded information as to works of the greatest interest to municipal engineers.

August 18, 1894.

On Saturday the carriages were requisitioned for a drive through the handsome outer boulevards. Wood, asphalt, macadam and stone roadways were seen, and a feeling of envy was aroused at the superiority of these spacious drives in comparison with anything of the kind in England. The Avenue Louise, by which the Bois de la Cambre was reached, is itself 1½ miles long, and is a stately highway to the beautiful park referred to. The fine old timber of the Forest of Soignies, and the undulating character of the land, have been taken advantage of to the fullest extent by M. Keilig, who laid out the Bois. Here the particular features of interest were the deep drainage works and underground reservoir, which have been carried out under the direction of M. Putzeys, to supplement the water supply of the City.

In the afternoon a municipal school in the Rue Haute was inspected, after which the Members visited the magnificent Palais de Justice. The cost of this building was given at 2,500,000*l.* The ground plan forms a rectangular area, 200 yards long by 187 yards broad, or about 37,000 square yards in extent. The arrangements for the heating and lighting of the building are most elaborate. M. Adolphe Engels, chief architect of civil buildings and conservator of the Palais de Justice, explained to the visitors the main features of the arrangements throughout the edifice.

2. MALINES—August 20, 1894.

On Monday the Members proceeded by rail to Malines, where they were met by Professor Kemna and drove to the Antwerp waterworks and filter-beds. Here Professor Kemna, the chemist to the works, conducted the party round, and explained in excellent English the process of purification with the aid of spongy iron, sand filtration and aeration, as follows:—

ANTWERP WATERWORKS.—THE THEORY OF SAND FILTRATION AND OF THE USE OF IRON FOR THE PURIFICATION OF WATER.*

BY PROFESSOR KEMNA.

WATER percolating through the soil gets purified. Simpson passed the water through a few feet of sand to obtain the same result; but a closer comparison would have revealed to him differences between the two processes.

First, as to composition: ordinary soil is composed of sand, limestone and clay, with very different absorbing powers, sand having little or none, clay, on the contrary, a large absorbent power. So that the filter is composed of the inactive part of the soil.

Second, the quantity of water passing through a filter is largely in excess of what even the most copious rain brings down to the ground. What are the few inches of rain compared with the 6 or 8 feet which a filter is made to deliver in 24 hours?

Third, and this is a very important point, while the working of a filter is a continuous one, the sand being always under water and its strata water-logged, the action of the soil is an intermittent one. During the dry periods the air gets in the pores, condensation of oxygen on the surface of the grains is rendered possible, and the layers so aerated become highly active.

Fourth, the division of the soil is much greater than that of a sand filter; this means that the particles of the soil have much smaller dimensions, and proportionately much larger surface than the grains of the sand.

No reasonable man would ever have gone to the great expense of making a sand filter in the face of that parallel. But the demands of the water engineer at that time were not very high, the chemistry of water analysis was a very poor thing, and microbes had not yet invaded the scientific world. As pointed out in Percy Frankland's admirable book, just published, it was not so much *purification* as *clarification* that was aimed at, and for this modest purpose the filter answered well. But when in later years the onward progress of science caused the hygienist to become gradually more troublesome to the waterworks engineer, it was found that besides its mechanical action of retaining the suspended particles, the sand filter did a good deal more. The search for organic matter revealed to the chemist a large reduction through filtration. Attempts were made to distinguish in this collective term "organic matter" two factors of very different hygienical bearing—animal pollution and vegetable pollution. Hence Edward Frankland's method of organic carbon and nitrogen, and the much more practical albuminoid ammonia method of Wanklyn. And here it was found that the filter acted most on the animal organic matter, which was considered as more dangerous. And when bacteriology interfered in a somewhat high-handed way, it was again found that the sand filter arrested microbes in an unexpected degree, and offered to the populations thus supplied a reliable protection against those zymotic diseases conveyed through the drinking-water.

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* A full description of the works has been given by Mr. W. Anderson in the 'Proceedings of the Institute of Civil Engineers,' vol. lxxxi. 279. Mr. E. Devonshire published in 1887 a pamphlet giving in detail his experience of the use of metallic iron for the purification of the water supply of different places.

In the meantime sand filters had spread all over England and also a good deal abroad, through the English companies which had taken on the supply of some continental towns. But Simpson's original plan had remained unaltered in its main features. The filters were worked by that special race of English foremen which has done so much towards the supremacy of English industry: they were worked with care and intelligence, but *practically* and somewhat with a contempt, or at least a disregard of theory. No progress occurred, nor could any advance be expected under such circumstances. It is only when the scientific turn of mind of the Germans was brought to bear on the question that new light was thrown upon it, and that the principles governing the action of the sand filter became known. What you have initiated and rapidly brought as far as possible with the practical knowledge alone, the Germans explained and perfected. This has occurred not with sand filtration alone, but with many other things, and as an instance, I will mention the aniline dyes: this Perkin invented and Hofman perfected. You had Hofman in London, but you did not keep him—you let him go. Now the German laboratories supply with chemical dyes the whole world, England included.

Just calculate what is your yearly loss of profit in thousands of pounds.

When ordinary river water is passed through *clean* sand, only the grossest particles are arrested, some organic compounds of high molecular weight are kept back by adherence to the particles of the sand, but this only in a small degree, and the number of microbes remains unaltered. Practically, the action of clean sand is *nil.* But after a few days the filter gets dirty : the top sand is more or less blocked up by the suspended particles arrested. Now these suspended particles are inorganic—mainly clay, the absorbent power of which is well known. It would be an interesting experiment to form a filter with a very thinly divided layer of clay at the top and watch the results. But some of these particles are organised, i. e. living—threads of algæ, microbes, &c. ; they thrive and multiply, and you find at the top of the sand a layer of felt, the interwoven filaments of algæ : the mazes of this felting are filled with a slimy substance, from the colonial organisms or zooglœa which have formed there. And now your dirty filter stops very fine clay, reduces organic matter, &c., and reduces and keeps back the microbes.

As the action of this dirty upper layer is all-important, it must be considered somewhat more in detail. It certainly acts mechanically, first by reducing the interstices, second by the stickiness of its substance. It is a grate, the meshes of which become gradually narrower. This is proved beyond doubt by the fact that the water passes with increased difficulty ; to get your quantity through, you must increase the head, and at the end the filter is so choked and its delivery so much reduced, that it is no longer of any use. The top sand must be scraped off and the filter restarted. It is a cobweb ; and here I must mention the theory of the cobweb as it can be gathered from the experiments of Professor Vernon Boys, with his quartz fibres. These fibres are extremely thin, so thin that their diameter falls within the limits of molecular actions. If therefore, such a fibre be moistened with oil, as the cylinder is not a form of equilibrium for liquids, as has been shown by the well-known experiment of Plateau, the oil cannot remain evenly distributed over the quartz core : it will collect into beads, alternately large and small. This is also the form of a water jet through a small circular orifice. Now, the circular threads of a cobweb (not the radial ones) show the same beaded structure, and this makes them to produce under a certain incidence of light a re-diffraction spectrum, the beads acting as a grating. And Mr. Boys' oiled fibres catch flies just as a cobweb does. It is an action of surface tension, and not due to the sticky nature of the fluid. In a sand filter we have the grains covered with a thin layer of semi-liquid substance, and when reading Mr. Boys' paper, it at once struck me that the two cases, or rather the three—the oiled fibre, the cobweb and dirty grain of sand—were similar cases.

The chemical part of the action of a sand filter has been considered in two very different ways. The retaining of some organic compounds has been ascribed to the somewhat obscure action of surface, and paralleled with the well-known purifying action of charcoal and the action of spongy platinum. But it remains to be seen in how far these comparisons are valid, and whether the sand has such an absorbing action. Laboratory experiments have not been made in this direction, and what has been said above of the inefficiency of clean sand is not in favour of such an action. The atmospheric oxygen has been said to condense on the surface of the grains, and to be brought thus into more intimate contact with the organic, which becomes so oxidised. In all that, there is a good deal of fancy and loose comparison.

The microbial school has offered another explanation. The reduction of organic matter is a question of fermentation. In the upper layers of the sand, the microbes have multiplied, and they thrive either by incorporating the dissolved matter or by burning it. This is very likely true to a large extent, and it is not necessary to show how this theory better falls in with the known facts.

From the great number of microbes in these upper strata, there is raging there a fierce struggle for life. Only those microbes can stand the competition which are best adapted to the special conditions of the environment. The others disappear, or are much reduced in number. This explains not only the numerical absolute diminution, but also the modification in the relative number of individuals of the different species, and the complete disappearance of certain forms. The proportionate flora of the water is completely altered by the filtration.

This is of the greatest importance for public health, as the micro-organisms causing disease are generally species which are much more liable to destruction than the ordinary aquatile bacteria. They want the higher temperature of the body, a more copious food, and in our rivers they are therefore under unfavourable conditions. Numerous experiments have been made to determine the resistance of pathogenic bacteria in water, namely with the cholera-spirillum and the microbe of typhoid fever. These experiments fall into two classes : one set of workers find the microbes destroyed after a few days, the other set being able to detect them after weeks and months. But these last results have generally been obtained by inoculating water after previous sterilisation, which, of course, has kept back any struggle for life, while in ordinary circumstances the introduced microbe had to fight his way against the primitive occupants.

Experiments have been made also with sand filters into which pathogenic microbes were introduced: the results have varied, but in a certain number of cases it seemed obvious that the sand filter had not kept back the special microbe. Against this conclusion, however, contrast the general run of observations in towns supplied by sand filters. In London, 90 per cent. of the water is sand-filtered, and the statistics show a remarkably low death rate. The preservation from cholera of the city of Altona in 1892 is a classical example, and I may say also that here in Antwerp the facts have been so clear that, although we have to deal with a very bad water, and our purified water leaves sometimes much to be desired, the necessity of enforcing its use wherever zymotic disease has appeared is practically recognised by the health authorities.

We have thus in sand-filtration a very cheap and convenient way of supplying a large city with wholesome water, and no doubt numerous lives have been saved in that way. But however high its efficiency, it has a limit, and when it came to the question of supplying Antwerp, it soon appeared that with the very bad quality of the only river available, this limit was too near.

In this emergency it occurred to one of the engineers whose firm had taken the concession for Antwerp, that other and more powerful means of purification should be looked for. Of the rather numerous forms of domestic filters so largely in use in England, one which had behaved very well was Professor Bischof's spongy iron filter, and Mr. W. Anderson applied to Professor Bischof as to whether that material would do on a large scale. Experiments were made at Waelhem with the Nethe water, and after several months the results were so satisfactory that the question seemed a settled one. A large stock of spongy iron was bought and placed in three filters, while three other ordinary sand filters were provided, to keep back by straining the oxide of iron formed in the water. The works were started in 1881, and all went on satisfactorily for a couple of years.

The increase of water supplied showed about 1883 an unexpected difficulty with the spongy iron filters, whose delivery had diminished to an alarming degree. These filters had got blocked by matter subtracted from the water, and through the clogging together of the particles of iron, which had become rusted all over. To overcome this it was thought necessary to keep the iron in motion, so that the constant rubbing of the small pieces should avoid them clogging together, and at the same time clean them, fresh metallic surfaces being always exposed to the water. After having tried various schemes, the most suitable apparatus was found to be a revolving cylinder through which the water passed, while some iron was constantly showered down through the water by being lifted up by shelves in the interior of the rotating cylinder.

It was first thought that a rather large quantity of iron should be put into the revolvers and that a long contact was necessary, so as to approximate as much as possible the condition of the primitive spongy iron filters, where the water had a contact of 45 minutes with the metal. But it was soon found out that the quantity of iron could be much reduced, and that a contact of a few minutes gave the same good results as three-quarters of an hour. This altered very materially the question, and rendered the use of the revolver so easy that it was at once resolved to replace the hundreds of tons of spongy iron by the new apparatus. This bold scheme was carried out in the beginning of 1885.

In the same year there was a very protracted drought, and the International Exhibition at Antwerp, caused an increased consumption; the water delivered to the town got very bad in appearance, complaints arose, &c. The author then became connected with the affair, first as an expert for the city, and later on as consulting chemist.

The situation of the company was at that moment a rather awkward one. Large sums had been spent on the experiments with the spongy iron, in buying that material, and for the revolvers, and the results did not appear satisfactory. The author first inquired as to the preliminary studies, and when it was found that a certain number of skilled engineers and chemists had devoted part of their time to it, and among them such renowned scientists as Edward Frankland and Sir Frederick Abel, it was thought that the question had been looked into to the very bottom, and the author felt greatly afraid that, coming after them, there was very little chance indeed of improving anything.

When going through the literature and comparing his own analytical results, which were rapidly accumulating, the author found that the facts had been correctly stated. However strange it may appear, the mere shaking up with iron for a few minutes increased the efficiency of filtration to a really marvellous extent. The total organic matter was reduced by 40 per cent., the albuminoid ammonia by 75 per cent., and there was a complete absorption of the free ammonia, although the river gave very often over one milligram per litre, which is 100 in Wanklyn's scale.

There were, however, but very scanty indications of the theory of this action—of the how and why of the process. Professor Bischof says that he cannot clearly explain how all these reductions are brought about, but that they *are* produced, and that is the principal thing. In other instances, however, it seems that he places his confidence mainly in the "action of surface." Professor Edward Frankland explained the destruction of microbes by admitting that iron behaves as a poison for lower organisms, while it is noxious to higher ones, but no special experiments were made to determine the correctness of this strange fact. It had puzzled the author from the beginning how hundreds of tons of spongy iron were first thought necessary, and the quantity afterwards reduced to a little over one ton per revolver; how the 45 minutes contact was brought down to 4, and how any form of iron, such as borings and punchings, all acted equally well as the costly spongy iron specially prepared. It may be said that, had the chemical theory been worked out more completely—and this was not a very difficult question—a good deal of trouble and expense would have been saved.

The action of the iron is, indeed, a very simple one. The free or loosely combined carbonic acid of the water dissolves the iron, and ferrous bicarbonate is formed. At the outlet of the revolver the water has a slight greenish colour and an inky taste, and the sulfocyanide reagent shows the presence of the metal. By exposure to the air, the ferrous salt transforms into ferric oxide, which parts with some of its oxygen to destroy the organic matter, as every housewife well knows, as she dreads spots of rust on the linen. But the ferrous compounds take up oxygen again, to play afresh the rôle of ferric acid.

Now mark the effect of a correct theoretical view on the practical side of the question. If the solution of iron in the water is due to carbonic acid, as soon as the quantity present is saturated, any prolongation of contact is useless, and a large amount of iron not necessary. If you want more iron dissolved, the quantity of carbonic acid can be increased by injecting into the revolvers the gases of the flue. As the quantity of dissolved gas and the dissociation tension of the bicarbonate are regulated by the pressure, there you have another way of dissolving more iron if wanted. And so there is a wide field open for improvement.

The fact that the water at the outlet of the revolvers contains as many microbes as before, at once disposes of Professor Frankland's theory of poisonous action. It can, however, be contended that this poisonous action is not an immediate one, and that it takes some time to effect the total destruction of life. There is certainly some truth in Professor Frankland's view, as it must be admitted that a flake of ferric oxide cannot be a very congenial medium for most microbes. But from what the author has been able to see, the withdrawal of microbes is more of a mechanical nature. The flakes of ferric oxide form around solid particles suspended in the water, and probably also around the bacteria; their size is thus increased to an enormous extent, and they are easily arrested by the sand, they being now too large for the small interstices. At the same time they are weighted, and this explains why decantation after purification has much more effect than with the water not treated by iron.

The flakes of oxide collect at the top of the sand and do not penetrate it. The successive flakes do not remain separate; they are a sticky substance, so they clog together and coalesce, forming a continuous, homogeneous and very thin layer, through which filtration goes on, not by interstitial run, but by a kind of osmotic process, and this layer is an organic substance and a good oxidiser.

There is a great difference between this layer and that which forms on an ordinary sand filter ; the colour of the deposit alone shows that difference. It is also somewhat tougher, and behaves like wet thin cardboard, so impervious at the end that you can see the water standing for hours in the shallow places of the filter. But the most important point is that the formation of this layer—the efficient part of the filter—is completely under control. By putting on the filter a certain amount of water with a known quantity of oxide in it, and, if necessary, renewing that water after it has deposited most of its rust, it is possible to give to the top layer a required thickness. It is especially here that the iron process compares favourably with ordinary sand filtration, as for the formation of the top layer one is entirely dependent upon the chemical and bacterial composition of the water, temperature, light and other natural agencies, which are completely out of reach. The iron process is more scientific.

In order to save time, and to hasten the formation of the upper dirty layer with ordinary filters, it is the practice at Berlin, for example, to spread over the surface of a freshly cleaned filter some of the top sand which had been scraped off at a previous cleaning, and which assists through its bacteriological composition, in rapidly forming over the whole surface a felt of algæ. For this dirty sand the engineer of the Stralauer Thor Waterworks has hit upon the nice euphemism of "ripe" sand.

Experiments have been made at Berlin, under Mr. Piefke's control, with the iron and the large sand filters. The daily analyses for microbes show that to get less than 100 colonies per cubic centimetre in the filtered water, at least 8 days' working are required, while water treated with iron gives this result after two or three days.

Waters of difficult chemical composition behave in a different way towards iron. Soft river water shows no reduction of hardness with the revolvers, while with the spongy iron filter there was a rather marked one; the prolongation of the contact is probably the cause as the various chemical actions are not simultaneous but successive. Hard waters purify better than soft ones, provided their hardness be due to carbonate and not to sulphate of lime; the Thames above London and the Seine at Paris are instances of waters which would be very easily purified, as a certain number of experiments have shown. Suspended particles of very fine clay, which are so troublesome to ordinary sand filters and so difficult to arrest, seem to act most favourably, probably as each suspended particle acts as a centre of *crystallisation* for the flakes of oxide. The case of Dordrecht, as explained in Mr. Devonshire's pamphlet, is a typical one; the Nile water during the flood is completely clarified by mere decantation in a very short time after shaking up with iron, while otherwise it remains turbid for weeks, and opalescent for months. Waters highly polluted with animal organic matter give a high rate of purification, the animal organic compounds being very unstable, and therefore easily destroyed by such a powerful oxidising agent as ferric oxide. The most difficult waters to deal with are those of peaty grounds, sometimes very highly coloured, but very clear, without any suspended matter; their acid nature causes them to dissolve the iron very easily, but their greater stability renders the re-precipitation of that iron sometimes very difficult. Sewage waters give widely different results, sometimes excellent, at other times no action at all. The author has not yet gone into that question, but thinks that with very alkaline sewage, iron cannot be dissolved, nor with sewage with a large quantity of sulphuretted hydrogen from the formation of the insoluble sulphide.

It is with companies as with nations and individuals; if their history is interesting it is a very bad thing, because the interesting parts mean trouble and suffering. Happiness tells no tale. The Antwerp Waterworks Company has, unfortunately, a good deal to tell; its history is a typical illustration of the English character, with its good and its deficient sides; but especially it illustrates the tenacity and indomitable energy of the Anglo-Saxon race, which at the end overcame the difficulties. As the manager of the Antwerp Waterworks Company, the author expresses the strong conviction that but for the use of iron this Company would either never have been started, or else would utterly have come to grief within a few years.

A very cordial vote of thanks was unanimously accorded to Professor Kemna for the valuable information he had given.

3. ANTWERP—August 21, 1894.

After a brief visit to the Hotel de Ville, the Members were shown over the maritime installations of the harbour. They saw in succession part of the Escaut quays, with their embankments covered with sheds, which as a rule are 50 metres deep, hydraulic cranes of the overhead type, of power varying between 1½ to 3 tons. The length of the quays is 3500 metres; the depth of water alongside the quay wall is 8 metres at low tide; the cranes are 62 in number, including one of 1-ton and one of 20-tons power. The Members afterwards viewed the channel and the old docks lock-gates, which allow passage to ships 18 metres in length, with a draft of water of 21 feet; the old docks with the Hanseatic House, which was used for warehousing corn (nothing but ruins now remain of this house, which was destroyed by a fire in November 1893); the Kattendÿk Dock and its lock, 24·8 metres wide, 150 metres long, and 22½ feet deep; the rolling bridge constructed over the lock to allow for the ordinary traffic and the trains to pass; the dry docks, six in number, of which four are large ones (three being 123 metres and one 110 metres long), one medium sized and a small one; the Lifebore dock (ex Africa dock), now building for the corn trade; the America Dock with its installations for petroleum in bulk and in casks; the timber dock; the Campine dock, which is especially reserved to the iron ore trade; the hydraulic works of the "Nord," possessing three compound engines of 150 horse-power each, and working at a pressure of 700 lbs. per square inch.

The excursion was ended with the visit to one of the two "promenoirs" of the Escaut quays, the hydraulic installation of the "Sud" where are two hydraulic machines of 250 horse-power each, working at a pressure of 700 lbs. per square inch, and an underground canal of an average width of 8 metres.

The chief of the service of the maritime installations is now M. Royers, chief engineer of the municipality. M. Royers, born in 1848, won his diploma of honorary engineer of the roads and bridges in 1870 as a student in the special school of engineering which is annexed to the University of Ghent. He immediately entered the service of the State in the administration of roads and bridges, and left this post in 1873 in order to enter the service of the City of Antwerp. Under his direction important works have been carried out, amongst which may be especially mentioned the equipment and installation of the Escaut quays (95,000 square metres of sheds and 60 cranes of 1½ to 3 tons); the two "promenoirs"; the hydraulic machinery of the "Sud"; the America and Lifebore docks; the extension of the Kattendyk dock and the new junction of this with the Lifebore dock; three dry docks with the conduit connected with that belonging to the old dry dock (this conduit has been constructed by means of compressed air); the equipment of the Hanseatic House for the warehousing of corn; the hydraulic equipment of the docks, comprising one 20-ton masting crane, two 40-ton cranes, one 10-ton crane, one 20-ton hand-power crane, one of 10, seven 2-ton, and twenty-two 1½-ton cranes; twelve 2-ton cranes are now being constructed, besides 120,000 square metres of sheds; the Steen, the building in which the various departments have their offices; schools, police stations, shooting ranges, swimming baths; a lock, now building, and which is to cost 2,000,000 francs, to connect the Lifebore dock direct with the Escaut; a new dry dock is contemplated, to be commenced at the close of the year, in the south part of the harbour, 180 metres in length with 25 feet 6 inches depth, estimated cost 3,000,000 francs; a system of drainage collectors, paving, &c.

The total cost of these works has amounted to no less than 80,000,000 francs.

A cordial vote of thanks was unanimously passed to M. Royers for the privilege granted to the Members in visiting the works, and for the courteous attention paid to them in explaining the various details.

DISTRICT MEETING AT BUSHEY AND HAMPSTEAD.

October 23, 1894.

A. M. Fowler, President, *in the Chair.*

The Members proceeded first to the Colne Valley Waterworks, where the following paper was read :

COLNE VALLEY WATERWORKS: BUSHEY PUMPING STATION.

By E. BROUGH TAYLOR, M. Inst. C.E.

These works supply a district of some 75 square miles, most of which lies in Hertfordshire, the smaller portion being in Middlesex. This large area extends from the boundaries of two of the London water companies up to the districts of Watford and St. Albans, and includes Sudbury and Wembley, Harrow, Pinner, Bushey, Elstree, Shenley, Edgware, portion of Hendon and other parishes. The average supply is about 1,000,000 gallons daily, the population at present supplied being about 45,000 and continually increasing. This is at the rate of 22 gallons per head per day, and the figure is satisfactory as indicating an absence of waste. The water is obtained from wells in the chalk formation, this stratum being found at the surface in the neighbourhood with thickness of about 690 feet.

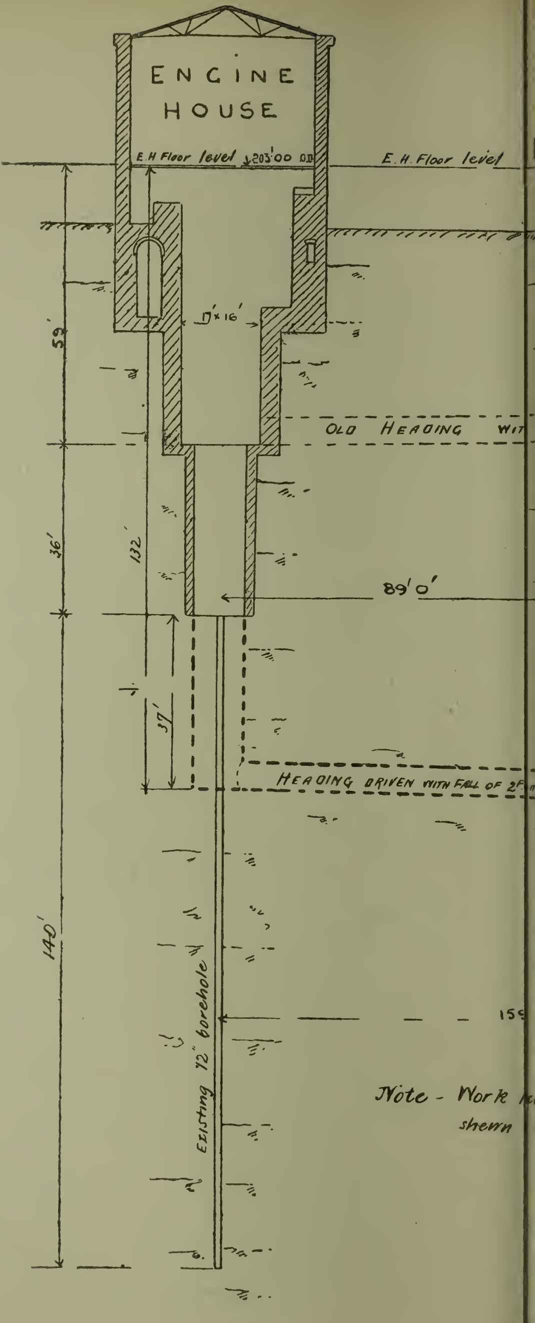
Water Supply Works.

The first well, which now forms the engine well, was sunk in 1874 by the late Mr. J. F. Bateman, past President Inst. C.E.

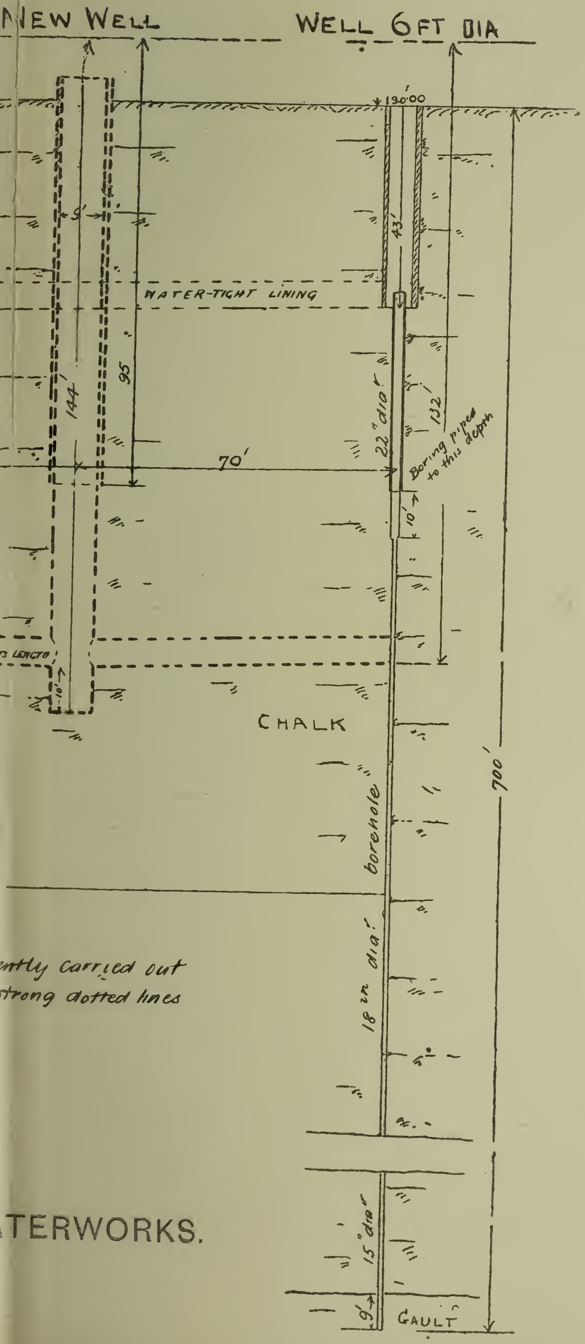
This was carried to a depth of 82 feet from the surface and continued by a bore-hole 11 inches in diameter and 140 feet deep below the bottom of the well. This first well is stated to have yielded about 820,000 gallons in 24 hours when first pumped out, but the yield gradually decreased to 600,000 gallons.

In 1881 it was determined to increase the available quantity of water; and with this in view a second well and deep boring were sunk and connected with the engine well by an adit below the line of saturation, so that the overflow from the new well should run by gravitation to the old well. This second well, which will be pointed out in the yard, is 43 feet deep and 7 feet diameter; from this depth a bore-hole 18 inches in diameter was sunk to a depth of 477 feet, being then reduced to 15 inches diameter and continued for a further depth of 180 feet through the chalk marl, ultimately reaching the gault at 700 feet from the surface. The quantity of water which this second well is stated to have contributed is 635,000 gallons per 24 hours, making with that obtained from the engine well about 1.235,000 gallons per diem.

When the author's firm was first called to advise the directors of this company, however, we found that this figure represented not the average, but rather the maximum, yield from the wells, the minimum at that time being scarcely 1,000,000 gallons per diem; and as the period of minimum yield in chalk wells occurs about the time of the maximum demand of the district, it was soon found to be urgently necessary to increase the yield by new works. The accompanying diagram will show the manner in which we effected the objects we had in view, viz. (1) to lower the engine well, so as to enable us to get the suctions of our pumps further down below the line of saturation; (2) to cut the deep boring at the lowest possible level, in order to liberate the water which would undoubtedly issue when the top pressure was removed; and (3) to form a new pump well in which at any future time additional pumping power could be placed. These works were successfully carried out by Messrs. Thomas Docwra and Son, and the result has been to give the company at least three times as much water as they had before, the available minimum yield being now well over 3,000,000 gallons per diem; and it may be noted in passing that these operations were carried on without any interruption in either the softening process or the supply to the district.



COLNE VALLEY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TERWORKS.

The Pumping Plant.

The next feature in these works which is of interest is the pumping engine, which was designed for the company in 1889, and manufactured by Messrs. R. Moreland & Son and set to work in 1891, since which time it has worked almost continuously, performing the whole of the company's pumping. It is of the compound beam type, with upper and lower lift pumps and surface condenser. The Lambert trip gear is introduced into this engine, and has given very satisfactory results. The principle of gears of this class is that the engine is controlled by a governor which, instead of actuating a throttle valve in the steam pipe, regulates the point of cut-off of the steam; so that any alteration of the load on the engine or in the steam pressure causes the length of steam admission to vary in accordance therewith; and even if sudden and considerable alterations in the load occur this gear will within a few revolutions cause the engine to resume its normal speed. The actual speed of the engine may be varied by altering the position of a balance weight upon a lever working from the sleeve of the governor. If the load is entirely thrown off —through the bursting of a pipe in the pumping main for instance, —the sudden increase of speed throws a portion of the Lambert gear out of engagement and completely shuts off the steam from the engine. The lower pump is furnished with a bucket at bottom and plunger at the pump head, and the upper pump is of the combined bucket and plunger type. The lower lift raises the water from the pump well and discharges it into the softening tanks, and the higher lift draws from these tanks and delivers its water through the pumping main to the reservoir. The pump horse-power of the engine when running 16 revolutions per minute is 133, and at this speed it discharges 1,400,000 gallons in 24 hours. The greatest head against the pumps occurs when the water in the well is low and the discharge is over a standpipe at the reservoir; in such case the total head may rise to 460 feet, or 200 lbs. pressure on the square inch. The steam is obtained from one or other of two Lancashire boilers 30 feet long and 7 feet diameter, steaming at about 80 lbs. pressure. These boilers were erected in conjunction with the new engine. The fuel ordinarily used is a mixture of small Welsh coal and gas coke, and with this is obtained a duty of between 70,000,000 and 80,000,000 foot-pounds per cwt.

of fuel, which also includes the fuel used in banking up and heating flues. At a forty-eight hours' trial this engine developed 109,000,000 foot-pounds per cwt. of best Welsh coal.

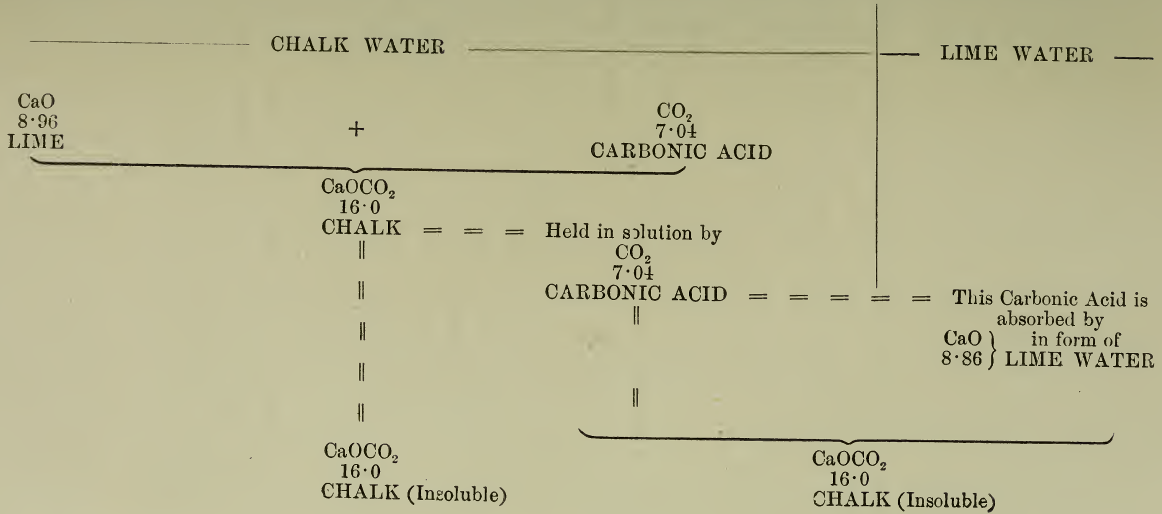
The Softening Process.

The chief object of the visit here to-day is, however, to inspect the process of softening the water; and as this is as much a chemical as an engineering question, one of the author's partners, Mr. Midgley Taylor, F.C.S., who has devoted a large amount of attention to water softening, has contributed the following account of the process and the works required for carrying it on:—

"Rain water falling upon the earth contains practically no dissolved solid matters and is perfectly soft, but holds in solution varying proportions of dissolved gases, including carbonic acid, which the rain has absorbed from the atmosphere. In percolating through the strata down to the underground natural reservoirs the water dissolves and carries with it any soluble matter with which it may come into contact, and owing to the presence of carbonic acid gas it is capable of dissolving carbonate of lime, or chalk, which would otherwise be practically insoluble. These various dissolved matters cause the hardness of water. It is apparent, therefore, that the dissolved salts causing hardness may be divided into two classes: first, those which are soluble in water by themselves; and second, those which are held in solution by the aid of dissolved carbonic acid. The salts in the first class cause what is termed permanent hardness, and those in the second temporary hardness, or that which can be removed by the expulsion of the carbonic acid, as in boiling, or by its absorption, as in softening. The chief salts which have a hardening effect upon water are the carbonates of lime and magnesia, causing temporary hardness, and sulphates of lime and magnesia, causing permanent hardness. The former salts, causing temporary hardness, will only be referred to, as that is all that can be removed by the softening process.

"The softening at these works is effected in the usual manner by adding limewater to the hard water; and for those to whom the process is not familiar the following observations will, it is hoped, make it so:—Sixteen ounces of chalk consist of 9 oz. of lime and 7 oz. of carbonic acid, and by burning the chalk the carbonic acid is driven off, leaving the 9 oz. of lime, which may be dissolved in not less than 40 gallons of soft water. This solution is called

Diagram Illustrating Clarke's Softening Process.



limewater. An average sample of chalk water is represented by 16 oz. of chalk, held in solution by 7 oz. of carbonic acid dissolved in 400 gallons of water. Now, when the solution of 40 gallons of limewater containing the 9 oz. of lime is mixed with the 400 gallons of chalk water containing 16 oz. of chalk and 7 oz. of carbonic acid, forming 16 oz. of carbonate of lime, which, being insoluble, precipitates, and the carbonate of lime being thus absorbed, the 16 oz. of chalk previously held in solution is likewise precipitated; the resultant, therefore, is 2 lb. of precipitated chalk in 440 gallons of softened water. The process thus consists of a simple chemical reaction, and one that is easily adapted for dealing with large volumes of water.

"The plant at these works comprises small stirring tanks, where the slaked lime is reduced with water to about the consistency of cream, two limewater tanks for dissolving the cream of lime to form limewater, and settling tanks where the reaction and deposit take place. The cream of lime from the mixer is run into the bottom of one of the limewater tanks, which is then filled with soft water, thoroughly agitated, and allowed to settle. The limewater thus made is then decanted into one of the settling tanks, when about ten times its volume of hard water is pumped in; the mixture is then left until complete settlement has taken place, when the clear softened water is pumped away to supply. It is found that with three settling tanks the pumping both of the hard water into the tanks and the softened water therefrom may be carried on continuously. Each tankful of softened water, if tested with nitrate of silver to ascertain that the whole of the lime has been neutralised and the degree to which the softening has been carried, is estimated daily. It may be stated that roughly the relative cost of softening water by lime, carbonate of soda, and soap, respectively, is:—lime, 1*s.*; soda, 20*s.*; and soap, 20*l.* Apart, however, from the commercial aspect of the case, the process undoubtedly tends to remove any organic impurity from water, if present, and therefore water treated in this way is distinctly improved for dietetic purposes."

DISCUSSION.

The PRESIDENT: Mr. Taylor will be very pleased to answer any inquiries as to the works or the process of softening. I should like to ask Mr. Taylor the degree of hardness in the water before treatment, and what it is reduced to.

Mr. MIDGLEY TAYLOR: About 24 degrees of hardness, and it is reduced to about 6 degrees.

The Members were then shown over the works, special interest being taken in the ingenious and successful methods adopted to reduce the degree of hardness of the natural water and to remove the large percentage of chalk present in its composition. The first part of the process consists in the preparation of lime water in a large indoor tank. Slaked lime is dissolved in water at the rate of 88 grains per gallon, and this lime water is allowed to flow in a certain proportion into the reservoirs into which the well water is pumped. The presence of the lime water has the effect of precipitating the chalk with which the well water is impregnated, the lime in the lime water is also converted into chalk, and the two volumes of chalk so produced are then removed from the water by settlement. This chemical treatment of the water has been proved by the experience of work to be a very decided success, the degree of hardness being reduced from 24 to 6 degrees. The method of treating the water was described to the parties conducted over the works by Mr. Brough Taylor, Mr. Midgley Taylor, and Mr. Santo Crimp, the members of the firm in engineering and chemical charge of the works. After the inspection of the reservoirs, which are uncovered,

Mr. SANTO CRIMP said: One thing we cannot lose sight of is this, that it must be an advantage to have the water exposed in tanks, owing to the effect of sunlight in killing noxious germs in the water, if present. A doctor at Shrewsbury discovered that many years ago, but as he was not a German professor it never saw the light of day as a great discovery.

Mr. J. LOBLEY: That is opposed to the effect of air upon well water. When it is exposed to the air it begins to grow Conferva.

Mr. SANTO CRIMP: We have got that in the Bristol water. It tends to grow it rapidly, but the water is not exposed in these tanks long enough to admit of weed growth.

Mr. Collins: I know several cases where the Local Government Board have had reservoir tanks covered.

The party then inspected the chalky deposit which is taken from the water, Mr. Santo Crimp remarking that they removed about 2 tons a day.

Mr. Collins: Of course you put a good deal of that into the water yourselves?

Mr. Santo Crimp: About 9 grains a gallon, and we take out more than three times as much—about 30 grains a gallon.

Upon the conclusion of the inspection of the works the Members were entertained to luncheon in the engine room by Messrs. Taylor Brothers and Santo Crimp.

The Members then proceeded by train to Hampstead, where, on their arrival at the new electric light station and works of the Hampstead Vestry, they were received by Mr. W. H. Preece, C.B., F.R.S., Consulting Engineer, and Mr. C. H. Lowe, under whose guidance they were shown over the works. Directly after the inspection of the works,

Mr. W. H. Preece, C.B., F.R.S., gave the following address upon the installation.

HAMPSTEAD ELECTRIC LIGHTING INSTALLATION.

Address by W. H. PREECE, C.B., F.R.S.

I am extremely sorry that our space here is so limited. We scarcely anticipated so many guests here to-day; otherwise, if we had known we might have provided more room; but I hope, at any rate, to give you an idea of what there is here to enable you to go and see for yourselves.

This electric lighting question in Hampstead has followed the usual history of electric lighting everywhere. Corporations and Vestries have desired to prevent the possibility of the introduction in their midst of another monopoly, like gas and water are in London, and they have all rushed very readily into the possession of Provisional Orders. It is one thing to get a Provisional Order; but it is quite another thing to persuade the Corporation or the Vestry to spend a large sum in carrying out the requirements of that Provisional Order. In this district, although we are very fortunate in possessing several far-seeing and able gentlemen on the Vestry, there was a very large body of opponents. We got over those difficulties; estimates were prepared; contracts were accepted; and the work has been carried out in a way which reflects the very greatest credit on the firm who received the contract—the firm of Messrs. Siemens. The name of Messrs. Siemens is a guarantee for the work being well carried out. The buildings were carried out under the superintendence and from the designs of Mr. Ardron, architect, and were built by a local firm, Messrs. Yerbury. They are admirably constructed and very well designed. We have to direct your attention to the system we are using and the prominent points of that system. We do not offer you anything very novel; but we do claim that the works are fairly well up to date. We are still on the threshold, in the very infancy of electric lighting, but these works are, I hope, as complete as any other in the country. Here we have to deal with a very scattered district. The plan here will show you that the population is principally concentrated in the neighbourhood surrounding these works; then there is old Hampstead, where it is also very much concentrated, but the outlying district spreads in a scattered way beyond the Heath.

It was only possible by the introduction of the high-pressure alternating system to meet economically the demands of all parts of the district. We have introduced the system here so that there is not a single inch of the district which cannot be served from the building in which we are assembled at the present moment.

The buildings consist of an engine room built in two spans, one of 26 feet and the other of 16 feet; the size of the engine room is 58 feet by 42 feet by 23 feet high, and it is large enough to accommodate a 50 per cent. increase in the glow and arc lighting machinery. The boiler house is covered by one roof having a span of 43 feet. It is 58 feet long and 24 feet 6 inches high; its floor is 9 feet below that of the engine room, which is on the ground level, thus allowing space for coal bunkers under the roadway. These bunkers will contain 100 tons of coal complete.

Separate lavatory accommodation is provided for the engine-room and boiler-house staff. The chimney is 130 feet high and 8 feet internal diameter. Up to a height of 50 feet it is divided into two compartments, only one of which is used with the present boiler plant, the other half being provided for extensions.

We have considerable room for expansion with the existing space. There is room for 50 per cent. more plant. We have sufficient plant for 30,000 lamps fixed, and with another small dynamo we shall be able to supply 40,000 lamps. But lamps fixed and lamps alight are different things. A house may have 100 lamps, but the proportion alight at one time is as an average not more than 50 per cent. In Hampstead it is much less; we find it does not exceed 26 per cent.

There is nothing particularly novel in the engine room, but I hope to be able to send you details and drawings of these works for your inspection later on.

The boiler house possesses four boilers of the Lancashire type. Each boiler is 26 feet long by 8 feet diameter, and is guaranteed to evaporate 5000 lbs. of water an hour, at a pressure of 150 lbs. per square inch. The material used throughout is Siemens-Martin steel, and each boiler has been tested to a pressure of 250 lbs. per square inch. The usual fittings are provided and include two safety valves, duplicate feedwater check valves, and mechanical stokers. Coal is supplied to the stokers by a coal elevator, consisting of an endless chain and buckets working in a short steel case, and a conveyor, consisting of a worm working in a trough, from which the coal falls through shoots placed at necessary intervals into the stoker-hopper. The stoking machinery is worked by a small vertical engine, provided in duplicate, and the whole is arranged with clutches, loose pulleys and striking gear, so as to be completely under control, and so that the breakdown of any portion of the machinery cannot interfere with the working of the station. There is a complete duplicate service of feed water to each boiler, a supply being obtained from the water company's mains, and also from a storage tank having a capacity of 10,000 gallons. There are two Worthington feed pumps, each of which can supply water to any or all of the boilers, independently of the other. The feed water is heated by an exhaust steam heater and also by a Green's economiser of 192 pipes placed in the main flue. Each heater is provided with a bye-pass, and each can be used together with or independently of the other. There is an advantage about the feed-water apparatus, which the experience of the next twelve months will show. Steam is taken from the boilers to the engines in a wrought-iron ring main divided by valves placed between each engine, and each boiler into sections, each section being drained. A small auxiliary steam ring connected to two sections of the main steam ring supplies steam to the feed-water pumps and stoker engines. The exhaust steam is carried to the atmosphere, 50 feet above the ground level, through a cast-iron exhaust pipe. We shall probably condense later on.

The engine room speaks for itself. You see we have Willans' central-valve engine. Willans' engine is one of which I have considerable experience. We have upwards of twenty in different post offices. They work with absolute perfection. They are a little costly, but they occupy little space and give immense satisfaction, and being direct coupled they are far preferable to a system of rope or pulley driving. We have four Willans engines. One is of 300 horse-power, driving a 200-kilowatt steam alternator. This is a machine capable of supplying 5700 8-candle-power lamps. Two 100-kilowatt dynamos, each capable of supplying 2850 8-candle-power lamps, each driven by a 150 horse-power Willans engine; and one small 20-kilowatt driven by a 30 horse-power engine for the day service. Altogether we have four of these dynamos for glow lighting. Then we have two 13-kilowatt steam dynamos for arc lighting, supplying twenty-two 2000-candle-power arcs; and two 18-kilowatt dynamos for exciting the above and for station lighting. Altogether we have eight engines and eight dynamos, four alternators and four direct-current dynamos.

The switchboard is well worth your looking at carefully. It is built up of polished slate panels, one panel being provided for each dynamo, and one for each circuit. Through these panels the alternators are connected by omnibus bars to the circuits, and are arranged to work in parallel, a synchronising panel being provided for the purpose. Each panel is provided with the necessary instruments for measuring the current and electric motive force, and the whole of the switchboard is mounted in a polished teak frame, and is railed off from the engine-room. The glow-lighting current, at a pressure of 2000 volts, is taken from the main switchboard by high tension feeder cables to seven sub-stations, each of which supplies a small area; all seven sub-stations being connected by low-pressure distributing mains. The feeders are Siemens H.C.N. type, protected with iron armour insulated with special fibrous material cased in lead, and are connected in the sub-stations to Siemens transformers which transform from 2000 to 105 volts, at which pressure customers are supplied. The low-tension mains are similar to the high-tension mains, but not so highly insulated. Barring accidents no customer can come within dangerous proximity of the 2000 volts pressure, which might probably kill him.

The sub-stations where cellars or premises cannot be obtained, are small brick chambers, 6 feet by 5 feet, and are built under the pavement, access being obtained through a small manhole in the top. Each sub-station contains two 25 kilowatt transformers, a high-tension fuse board, and a low-tension switchboard, from which the distributing mains are taken and so arranged that the supply to any length of distributing main between two sub-stations can be cut off for the purpose of connecting customers, without interfering with any other part of the system. Each sub-station will supply 1430 8-candle-power lamps. The total length of low-tension main is 3½ miles, and is sufficient to supply 10,000 8-candle-power lamps.

For street lighting 22 Siemens 2000-candle-power lamps have been erected on iron posts in the Finchley Road. Each lamp-post consists of a substantial cast-iron base surmounted by a wrought-iron stem and an arched bracket. The arc lamps are connected up in series and are supplied with current through a Siemens cable protected with iron armour and insulated with vulcanised rubber.

I have always been a warm advocate for electricity for street lighting, but then only to light a small area on a large scale and to do it as well as you can. The chief advantage of the electric light in the streets is as an advertisement; it attracts the attention of the whole parish to the merits of the light. At Bristol the whole of the main thoroughfare from the railway station through the town to the Victoria Hall, Clifton, has been lighted by arc lamps—there are 100 of them. Along that route the electric light has been taken up with such avidity that there are 33 per cent. of the shops lighted by electricity, while in other parts of the town which are served there are only about 5 per cent. This is very largely due to the introduction of street lighting on a very brilliant scale.

Our only misfortune here has been with the street lighting. On October 11th we were not ready, but we lighted up for the first time, and everybody was pleased, but no sooner had our masters, the Vestry of Hampstead, disappeared, than first one fault and then another developed itself. I was compelled to reject the armatures, so that we have not started the light yet in the streets. In about a fortnight's time our arrangements for street lighting will be complete, and then it will go with the same success as everything else.

There is a rumour throughout the parish that the whole thing has broken down. A meeting of the Ratepayers' Association has been held, where a resolution was passed that my commission should be stopped. I do not mind these little things. A man can only do his duty, and cannot do more. Here the industry is very successful. I am certain of this—that the electric lighting industry in Hampstead is going to be financially a very great success, and I am quite satisfied that there will never be any demand upon the rates for any assistance at all. I think we shall pay our interest on borrowed money the first year. We have only been open three weeks, and we have 2176 lamps fixed, 1218 in hand, and we have orders for 4475 lamps more, so that in less than a month we have got practically a load of 7869 lamps. We only started with the idea of getting 10,000 lamps in two years. My impression is we shall have 20,000 lamps in less than twelve months.

I have here a load curve showing the way in which the current is distributed during the day. This is one of the greatest difficulties with electric lighting. You have between the hours of four and twelve at night a very good and paying load, but you have during the rest of the twenty-four hours practically nothing. At Worcester we are trying a very important experiment indeed. We have there some water power available, and we are going to use this water power during the day in working pumps at the waterworks, and also in pumping sewage up to a higher level. The result is this—we shall have during the day a load which will compare very favourably with the night load. And we shall have a continuous curve which will pay our expenses day and night. With this curve (at Hampstead) we are paying during the night but not during the day; but if you can use the power during the day you reduce your expenses and the cost of the light. If you can reduce your expenses during the day you reduce the expenses of the night load. We started at Worcester with an exhibition, and what with street lighting and the local exhibition, the thing was so well advertised that the people are pouring in to be first in the field for the light.

We have been within our estimates at Hampstead. That is an unusual thing for an engineer to say, whatever it may be for architects. It is rather a compliment; at any rate, I think so. We are within our estimates in the contracts, and under our estimates in the business. I am quite sure the electric lighting is going to be practically and financially a great success.

DISCUSSION.

Mr. Cockrill: What price are you charging for the light?

Mr. Preece: The charge per unit is 6*d*., and we have a sliding scale according to the amount of current taken by our customers, which varies from 6*d*. down to 4*d*. We have one very large customer indeed, the North Western Hospital. If it takes 70,000 units it will be 4*d*., 50,000 would be 4½*d*., and 40,000 4¾*d*.

Mr. Cockrill: That is for lighting purposes.

Mr. Preece: Yes, that is for lighting. We shall reduce the price for current supplied during the day for power purposes, it will be 3*d*. probably.

Mr. Cockrill: I believe you consider arc lighting in the street is an incentive to people in shops using the electric light?

Mr. Preece: Yes, it attracts attention. Then, when they find it comes out cheaper than gas, they take the light.

Mr. Charles Jones: Can you give us the entire cost of the installation?

Mr. Preece: I cannot tell you with accuracy. I think we have spent something like 30,000*l*.

Mr. Mann: In estimating that there will be no charge upon the rates, do you allow for maintenance and depreciation?

Mr. Preece: We are borrowing money, redeemable at 25 years, and we have to pay interest that includes repayment of capital. In electrical apparatus of all kinds you must maintain up to the hilt; you cannot allow depreciation to take place. The only point in which depreciation comes in is the boiler, and that is a small matter. The electric plant must be maintained up to the hilt; it is always under renewal.

A Member: Will you give us the price for mains per mile?

Mr. Preece: I cannot remember. I think for the high pressure mains it runs not very far short of 1000*l*. a mile, laid complete.

Mr. Cockrill: I take it the great bugbear is the difference between the day and the night load.

Mr. Preece: If you can make the day load the same as the night load, the cost could be reduced very much. The cost to us will be 3*d*. per unit; if we had a day load, it would be less than 2*d*. per unit.

Mr. Cockrill: Can you give us any idea what the effect of the destruction of refuse for the creating of electrical power will have upon the cost of production?

Mr. Preece: As a very cautious electrical engineer, I am going to wait to see the results of the experiments made by the Municipal Engineers.

A Member: What is the price of coal?

Mr. Preece: About 14*s*. per ton. We are using the best Welsh coal, which comes to rather more, but we hope to use the ordinary north country coal later on.

The President, in proposing a vote of thanks to Mr. Preece for his address, said: We are extremely obliged to you for the very lucid and clear statement you have laid before us, and for the valuable address you have read to us. I am sure that to us, as Municipal Engineers, the information you have given to-day has been most valuable. There are many points in connection with the address which I particularly noticed. The stoking of the boilers from coal bins on the level of the stoke-hole floor must result in a considerable saving of labour. Then many of us have had experience of Green's economiser, and know it as a very excellent apparatus. I am introducing it at the sewage works at Stockport. The direct driving of the dynamos, instead of by ropes or pulleys, must also be of great advantage. I have to thank you, in the name of the Association, for your generosity in laying all these points before us, and giving us so much information respecting this installation. I am sure we are all thankful to you for it, and we shall only be too pleased to reciprocate the compliment, whenever you may visit any town represented by any of us.

Mr. Lewis Angell, in seconding the vote of thanks to Mr. Preece, said: What has struck me is the unreserved manner in which Mr. Preece is always ready to give information about his works. The sly poke at the architects just now may not have been understood by all the Members, but I may say it had reference to something which happened while I had the honour of being Chairman of the Science Committee of the Royal Institute of British Architects, before whom Mr. Preece read an interesting paper. Mr. Preece is one of the most eminent authorities on electric lighting, and whatever authorised institution applies to him, he gives the most unreserved information.

The vote of thanks having been unanimously accorded,

Mr. Preece, in acknowledgment, said: I am a Government official, and as a Government official, I feel I am bound as a servant of the British public to do all I can for my masters.

Light refreshments, provided by Mr. Lowe, having been partaken of, the proceedings terminated.

DISTRICT MEETING AT MIDDLESBROUGH.

November 22, 1894.

Held in the Council Chamber, Middlesbrough.

A. M. Fowler, President, *in the Chair.*

The President, in opening the proceedings, expressed his deep regret at the deplorable circumstances under which the Members of the Association had met together. They had to lament the sad death of an esteemed friend and Member, Mr. E. D. Latham, who had been for many years borough engineer of Middlesbrough and a Member of their Association. He was not aware of Mr. Latham's death until after his arrival in Middlesbrough, and if it had been possible that meeting would have been postponed. He proposed that "The Association of Municipal and County Engineers wish to convey their deepest sympathy to Mrs. Latham and family in their great bereavement in the loss of Mr. E. D. Latham, borough engineer of Middlesbrough, who was a Member of this Association."

Mr. Stainthorpe seconded the proposition, which was passed unanimously.

On the motion of Mr. Thorrold, seconded by Mr. Stainthorpe, Mr. Howcroft was re-elected as Honorary Secretary of the Northern Counties District.

ARRANGEMENTS FOR STERILISING CHOLERA DEJECTA, ETC.

ADOPTED AT NEWCASTLE-UPON-TYNE.*

By W. G. LAWS, M. INST. C.E.

DISCUSSION.

The PRESIDENT : I wish to invite discussion on Mr. Laws' paper. The paper is thoroughly up to date and shows the great advance which is being made in sanitation by our large towns. The present activity in works of sanitation is very different from the neglect which used formerly to exist. Within my own personal recollection the drainage of a cemetery in a large town used to go into an open brook running alongside a public footpath. I can also remember the time when at Inderwell, water for drinking purposes used to be drawn from a well in the graveyard, and at Poulton, a bootmaker had his wife's body buried on the outer side of a wall, within a few inches of where he sat and worked. The change which has come over the mind of the country with respect to sanitation since those days is shown by the care taken by Mr. Laws to prevent germs of infection getting into wells or disused mines from which water might be used for water supply. The paper is very carefully prepared.

Mr. SPENCER : There is one important point which we might have some further information upon—that is the cost of the apparatus. No doubt Mr. Laws has gone fully into the question of cost and would be able to give us the information. I do not know whether he has had the apparatus fitted up so as to know the actual cost, but at any rate he would know the estimated expense of apparatus, or cost per head of patients. This is rather an important point, as one of the greatest problems we have to solve at the present time with respect to infectious hospitals and infectious disease is to provide something simple, inexpensive and temporary in its nature to meet these epidemics. It is becoming generally understood, not only among sanitary engineers, but among those more important people who have to provide the ways and means, that to build large hospitals with expensive and elaborate arrangements which may never be used, is not the best way of meeting epidemics. Mr. Laws' paper is important with respect to one branch of the subject, in describing a method which is simple, convenient, cheap, easily handled, and which, supposing it deteriorates by time, may be renewed without great expense. That is the whole secret by which these unfortunate recurring epidemics are to be met. We cannot provide costly hospitals on every rumour of disease, for there are a hundred rumours for every case of disease which actually reaches our doors. At the same time we are not justified in ignoring disease; hence the importance of dealing with it by cheap temporary expedients. One great difficulty with the erection of infectious hospitals is that of drainage. Some engineers suggest separate drainage, others that the sewage should be dealt with before going into the common sewers. The mode by which the sewage has been dealt with hitherto has not been satisfactory, and I fear that many cases of infection could be traced to the want of proper sanitary arrangements. It seems to me we have put before us in this paper a scheme which is more likely to be satisfactory than any I have yet heard proposed. The only point is whether it can be carried out at such a reasonable expenditure that the smaller districts can adopt it. Of course in Newcastle-on-Tyne it is different. They have almost unlimited means to go upon, and the amount of money available there may justify the expenditure on elaborate arrangements. But the smaller districts must do something within their means, and the question is whether the mode suggested here is one likely to meet their case.

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* Paper read at the Annual Meeting, London, June 1894. See vol. xx. p. 222.

Mr. Laws: We have practical proof of the cost of the machine, having bought five of them and erected two. I am happy to say we had no need to erect more. The total cost of the sterilising pot ready for action is 30*l.* That does not include the steam boiler and pipes. But as about a hospital, steam is used for washing, for the disinfecting of clothes, and many other purposes, I do not think it would be fair to put the whole cost of the boiler on to one sterilising pot. In our case, supposing we had erected the whole of the six wards, the cost of the whole of the sterilising machinery would have been something like 300*l.* That is the full cost, with the boilers, pipes and the sterilising pots. I am happy to say we never had the opportunity of trying the machine on actual cholera sewage, but I have tried it on the nearest approach I could get, on sewage which had not the germs but the outer effects of cholera, and have seen the pot work most successfully. The time from closing the lid, turning on the steam and ejecting the sewage does not exceed five minutes, and the pot is left clean for the next charge. There is nothing to wash out. What we propose to do with the apparatus we have on hand after pulling down the temporary hospital is to erect the steriliser at our permanent hospital. There is an idea among medical men in favour of having their permanent hospital sewage sterilised before it goes into the sewers, and that we propose to do.

The President: Mr. Spencer evidently believes prevention is better than cure. I quite agree with him. If we can keep out the causes of infection we shall arrive at a very important stage in sanitation. The Association has already passed a very hearty vote of thanks to Mr. Laws for his paper, and I ask the Members to reaffirm that expression of thanks for his presence here to-day.

The vote of thanks having been adopted,

Mr. Laws said: I am much obliged to you.

THE FLOATING HOSPITAL BELONGING TO THE RIVER TEES PORT SANITARY AUTHORITY.

By T. W. STAINTHORPE,

Surveyor to the Eston Local Board.

The River Tees Port Sanitary Authority was constituted by an order of the Local Government Board on the 22nd day of January, 1886, and consists of seventeen members elected from the following riparian authorities, viz.:—

	Members.
Middlesbrough	7
Stockton	3
Eston	2
Thornaby	2
Stockton (Rural)	2
Normanby	1
	17

The special function of this authority, which is one of the most active in the kingdom, is to inspect every ship which comes into the river Tees and to see that all sanitary defects are promptly remedied, as well as to deal with all cases of infectious diseases and sickness which may be found among the crews. This duty, of course, involves the provision of a suitable hospital to which all patients can be removed and in which they can be properly treated by a specially trained matron and staff of nurses. The river Tees has an average of 60,000 seamen entering it every year in sailing and steam ships from all parts of the civilised world. To show the importance of the river from a shipping and commercial point of view, the following statistics have been tabulated from information which has been kindly supplied by Dr. Malcomson, medical officer, and Mr. Jefferson, inspector, the energetic and obliging officials to the port sanitary authority, also by C. T. Ellington, Esq., of H.M. Customs at Middlesbrough, viz.:—

	1892.		1893.	
	Vessels.	Tonnage.	Vessels.	Tonnage.
Inwards	3,730	1,424,033	4,372	1,953,421
Outwards	4,063	1,610,869	4,766	2,162,733

Value of imports in 1892	£911,301
„ exports „	1,939,786

From the time the authority was constituted until the autumn of 1892, the only provision they possessed in the shape of hospital accommodation was the hulk of an old brig sailing vessel, which was fitted up with six beds to receive patients and moored in the river near Newport. In October of the same year it was found that the old hulk was getting very leaky, and that a considerable sum of money would have to be expended to render it safe for such a purpose. At this juncture Dr. Malcomson, their medical officer, strongly urged upon the authority the absolute necessity of having a suitable hospital for the river Tees. It was then decided to construct a proper hospital of their own, and in the meantime a block of eight cottages at Seaton Snook were rented from the Tees Conservancy Commissioners and turned into a temporary hospital until the new hospital was completed. The authority gave the question of the new hospital a great amount of consideration, and before finally deciding upon the scheme to adopt they called in Mr. W. G. Laws, the city engineer of Newcastle-on-Tyne, to advise them. After careful consideration and inspection of the river Mr. Laws recommended that they should erect a floating hospital and moor it on the north side of the river about half a mile below the Eston jetty. This recommendation was adopted by the authority, and the necessary plans, detail drawings, specifications and quantities were prepared, and the sole contract was given to Messrs. Head, Wrightson and Co., of Thornaby-on-Tees.

Berth and Breakwater.

By arrangement with the Tees Conservancy Commissioners the site selected was obtained and a berth or dock was dredged out and a large breakwater in the form of a crescent was constructed of slag to protect the hospital from the fierce gales which occasionally blow from the north and north-east. The construction of this breakwater has taken several thousands of tons of slag, which have been deposited by means of shallow hoppers and barges.

Construction of Hospital.

The construction of the hospital may be conveniently divided into two parts—viz. the float and the hospital buildings proper. The float consists of ten cylinders, 86 feet 6 inches long by 6 feet in diameter. They have hemispherical ends, and the plates are of $\frac{3}{8}$-inch wrought iron of the best ship quality, jointed and single riveted with ¾-inch rivets, 2½-inch pitch, and caulked so as to be perfectly water-tight. Each cylinder has a diaphragm across the centre of its length, extending from the bottom to within 2 feet of the top, also two manholes, with specially made covers, to give access to the interior. Each cylinder has also two 2-inch brass valves, securely bolted to metal seats, and long handles so that they can be turned from the deck. All the cylinders were tested for tightness before they left the maker's yard by being filled with water for about 24 hours. The displacement of these ten cylinders is 650 tons.

No. 9 rolled-steel girders, each 140½ feet long by 12 inches deep, connect the cylinders, being fixed on curved saddles which rest upon and are riveted thereto. Screw bolts connect the saddles and the girders resting thereon, so that any one cylinder may be released and partially sunk by admitting water through the valves above mentioned, and towed away for repairs or painting. The cylinders are fixed 14 feet 6 inches from centre to centre. The girders are braced together with 4 inch by 3 inch by ½ inch T-iron diagonal bracing attached to square plates ½-inch thick and riveted to the under side of the upper flanges. To ensure perfect rigidity of the float, three large beams, 18 inches square, are fixed at right angles to, and under the cylinders, the full length of the float. The beams are secured to the main girders by a number of 1½-inch large screw bolts, fixed at an angle of 45°. Access to each cylinder is obtained by means of two watertight manhole covers fixed on the upper side. There is also a trap-door in the deck immediately over each manhole. The height of the deck above the water-level is 4 feet; and a sloping gangway leads to a broad landing which is level with the deck of the steam launch belonging to the authority, so that very easy access is secured between the launch and the deck. This steam launch is a very fine little craft, and is properly fitted up with all the necessary appliances for the removal of patients from the ships to the new hospital. At right angles with the main girders there are laid 11 inches by 4 inches creosoted redwood joists, 4 feet apart. These joists are secured to wrought-iron chubbs riveted to the upper flanges of girders. Upon these joists the deck is laid, and consists of 11 inches by 3 inches creosoted planks with close joints, and well spiked down with 6-inch spikes. A strong pitch pine open handrail 3 feet 9 inches high is fixed right round the edge of the deck, and a neat gate with hexagonal posts is provided at the top of the landing stage.

MOORINGS.

The moorings consist of No. 6 wrought-iron cables, the links of which are 1½ inch in diameter. These cables are fixed to heavy piles driven into the bed of the river, and to very strong double bollards fixed on the deck and bolted right through to massive beams below. The construction of the breakwater and all the work in connection with the moorings was done by the River Tees Conservancy Commissioners under the direction of Mr. G. J. Clarke, their able and respected engineer.

DESCRIPTION OF MAIN BUILDINGS.

The buildings erected upon the float consist of two ward blocks and a large administrative block midway between them. Immediately situated behind the administrative block are the laundry, mortuary and the "destructor."

The ward blocks are each 68 feet long by 24 feet 6 inches wide by 12 feet 6 inches high to the eaves inside, and 21 feet to the ridge. No. 1 block consists of one small ward 13 feet 6 inches by 23 feet 6 inches, and one large ward 42 feet 6 inches by 23 feet 6 inches. The small ward contains two beds, and will be used as the receiving or isolation ward, where the patients will be kept until their cases are properly diagnosed. The large ward contains eight beds, and both these wards are provided with a watercloset and scullery in small blocks attached to the main buildings. Between these wards the nurses' rooms and the bath rooms are placed. A covered verandah gives access to the entrance lobbies of the two wards, and also to the nurses' room.

No. 2 block consists of one small ward 21 feet 6 inches by 23 feet 6 inches, and contains four beds, and a larger ward 32 feet by 23 feet 6 inches, containing six beds. The arrangement of the nurses' room, bath room, water-closets and sculleries are exactly the same as in No. 1 block. The administrative block is 58 feet by 30 feet by 10 feet 6 inches to the eaves, and 20 feet to the ridge, and has an open space of 28 feet on each side between it and the ward blocks. It consists of the following rooms, viz.:—Matron's room, which will also be used as the dining room, kitchen, scullery, larder, stores, medical officer's room, and four double-bedded rooms 10 feet by 10 feet for the matron, day and night nurses and servants. There are also small rooms provided for linen, pots and pans, coals and stick houses, &c. A corridor 4 feet 9 inches wide runs along the centre of the block and has a neat lobby and a door at each end. The medical officer's room is so arranged that he need not pass beyond the front lobby door to gain access to it.

The laundry is 26 feet by 14 feet inside and has a good lofty open roof with louvred ventilator on top to carry off steam, &c. It has a good floor made with Jones's annealed concrete flags 3 inches in thickness; and is provided with boiler, washing machines and enamelled washing troughs, radial heating chamber for the quick drying of clothes, circulating cylinder for hot-water supply, wringing and mangling machines, steeping trough, and all the latest appliances for laundry work. The whole of these fittings have been supplied and erected by Messrs. Bradford and Co., of Salford, Manchester.

The mortuary is a small detached building 11 feet by 8 feet, with open roof, and is well lighted with open skylights. The floor is flagged and a neat bier with slate slab 6 feet 6 inches by 2 feet 6 inches is placed in the centre. The "destructor" is a specially constructed furnace 7 feet 6 inches long and 6 feet wide, by 4 feet 6 inches in height, built in firebrick and provided with suitable fire-bars for burning infected bedding, clothes or refuse. The whole of the brickwork is covered with wrought-iron plates and tied together with strong wrought-iron tie rods.

This "destructor" has been supplied by Messrs. Goddard, Massey and Warner, of Nottingham.

CONSTRUCTION OF BUILDINGS.

The construction of the main walls of all the buildings is as follows:—The outer framing consists of 4½-inch by 3-inch studs fixed 14 inches apart, secured to 7-inch by 3-inch rough sill plates half lapped at angles and joints, and to 4½-inch by 3-inch eave plates. The vertical studs are well strutted with 4½-inch by 3-inch rows of horizontal bracing; the angle posts are 5½ inches by 5½ inches and rebated on the inner angle to receive boarding. The outside is covered with a layer of thick felt and galvanised corrugated iron, No. 20 B.W. gauge. The inside partitions are made with 3½-inch by 2½-inch studs fixed and braced together as before described. The whole of the interior walls and ceilings in the ward blocks are lined with ½-inch dressed, grooved and tongued, V-jointed pitch-pine boards 4½ inches wide. The walls of the administrative block are lined with ½-inch grooved and tongued V-jointed selected redwood boards of the same width. All the floors are laid with 4½-inch by 3-inch joists resting upon 4½-inch by 3-inch plates spiked to the deck, and are covered with 1¼-inch grooved and tongued selected whitewood flooring boards, and have 1½-inch by 1½-inch bevelled pitch-pine angle fillets to prevent the accumulation of dust, &c., in the angles. All the internal woodwork is varnished with two coats of good oak varnish.

The whole of the roofs are framed with good strong principals, the feet of which rest upon neatly-shaped brackets. The spars are covered with ¾-inch grooved and tongued sarking, over which is a layer of felt and galvanised corrugated iron, the same as used for the walls.

All the windows are double-hung, and are provided with neatly-panelled double-hung shutters. This provision of shutters was absolutely necessary, and insisted upon by the Tees Conservancy Commissioners on account of the lighting and navigation of the river. All the internal doors are provided with Kaye's patent brass locks, which answer admirably for a building of this description.

HEATING.

The heating of the wards is by means of Musgrave's "Ulster" stoves, one in each of the small wards and two in the large wards. These stoves are covered with glazed tiles of neat design, and are provided with a locking arrangement, the key of which is kept by the nurse in charge. This precaution is taken to prevent any delirious patient playing or interfering with the fires. They give off a large volume of heat, and the temperature can be easily regulated. The rooms in the administrative block have each a small "Tortoise" slow-combustion stove with cast-iron flue pipes covered with a thin copper pipe. Special precautions have been taken to prevent fire from the flue pipes passing through the ceilings and roofs by means of light steel and cast-iron saddles. All the flue pipes have a Kite's stove cabin cap fixed on the top, and are secured by double wrought-iron stay rods to the roofs. The kitchen has one of Smith and Wellstood's cooking ranges fixed upon 3-inch flags covered with a steel plate ½-inch thick to prevent firing the floor.

WATER SUPPLY.

There is a 300-gallon cistern fixed in the roof above the ceiling of each block for fresh water supply. Hot water is obtained in the wards by means of one of Hartley and Sugden's harness-room boilers fixed in the nurses' rooms. The hot water in the administrative block is obtained from a boiler at the back of the cooking range in the kitchen. All the boilers are connected with 30-gallon copper circulating cylinders. The bath rooms and sculleries have hot and cold water laid on, and the wards are provided with portable baths with rubber-tyred wheels. As there are, of course, no water mains, special provision has been made to get the fresh water into the supply cisterns. This is done by means of a 1½-inch lead pipe for each block of buildings carried under the deck to the river side of the hospital. It is proposed to convey the fresh water down the river for the use of the hospital in a proper water boat and pump therefrom into the cisterns. The connection between the water boat and the 1½-inch lead pipes will be by means of a short length of flexible hose pipe with suitable union joints.

There is one of Warner's 2½-inch force pumps in each scullery for pumping the river water into cisterns fixed in the roofs over the water-closets. This river water is used for flushing the water-closets and slop hoppers. For the laundry water-supply the whole of the rain-water from the roofs is conveyed by down pipes into large water butts with brass drain-off taps. A large rain-water cistern is fixed under the laundry floor to receive the contents of the overflow from the water-butts, and a small force-pump will lift this water into a cistern fixed in the laundry roof which has a capacity of 160 gallons. Should the rain-water not be sufficient in a droughty season fresh water can be pumped from the river boat direct into this cistern.

VENTILATION.

Great care has been taken to secure thorough ventilation in the wards. This is secured by means of double-hung sashes, and the upper portion of the windows have a swing sash opening inwards worked by Leggott's fanlight opener. By this means the swing sashes can be opened and fixed at any width required. Immediately under the head of each bed, and level with the floor, is fixed one of Kite's fresh air inlet ventilators. The vitiated air is removed by ventilating shafts, 18 inches square, carried through the roof and widening out to 3 feet square at the level of ceiling. Through these shafts the flues from the stove pipes are fixed, and the heat from the flues creates an upward air current. Light folding iron flaps worked by cords passing over pulleys are fixed at the bottom of the 18-inch shafts, and these flaps can be set at any angle, and can be very easily worked by the nurses in charge.

The floors of each block are raised 9 inches above the deck level, so that there is ample space for a current of air to pass under them.

Waterclosets, Sculleries and Lavatories.

The waterclosets are provided with Shanks' patent "Crown" encased safety wash-out closets and large special flushing cisterns fixed upon cast-iron brackets. The flushing pipe from these cisterns is 1¼ inch in diameter. The sculleries are fitted up with enamelled fireclay sinks, 8½ inches deep, and porcelain slop hoppers with square top and trap. The bath rooms are provided with Shanks' patent "tip-up" lavatory basins fixed into polished slate slabs with slate skirtings.

Serving Table and Hatch.

The matron's or dining room is provided with a serving hatch from the kitchen. This will save a great deal of work in conveying food, &c., between the kitchen and the dining room, and will also cut off the odours of cooking from the corridor and rooms in the administrative block.

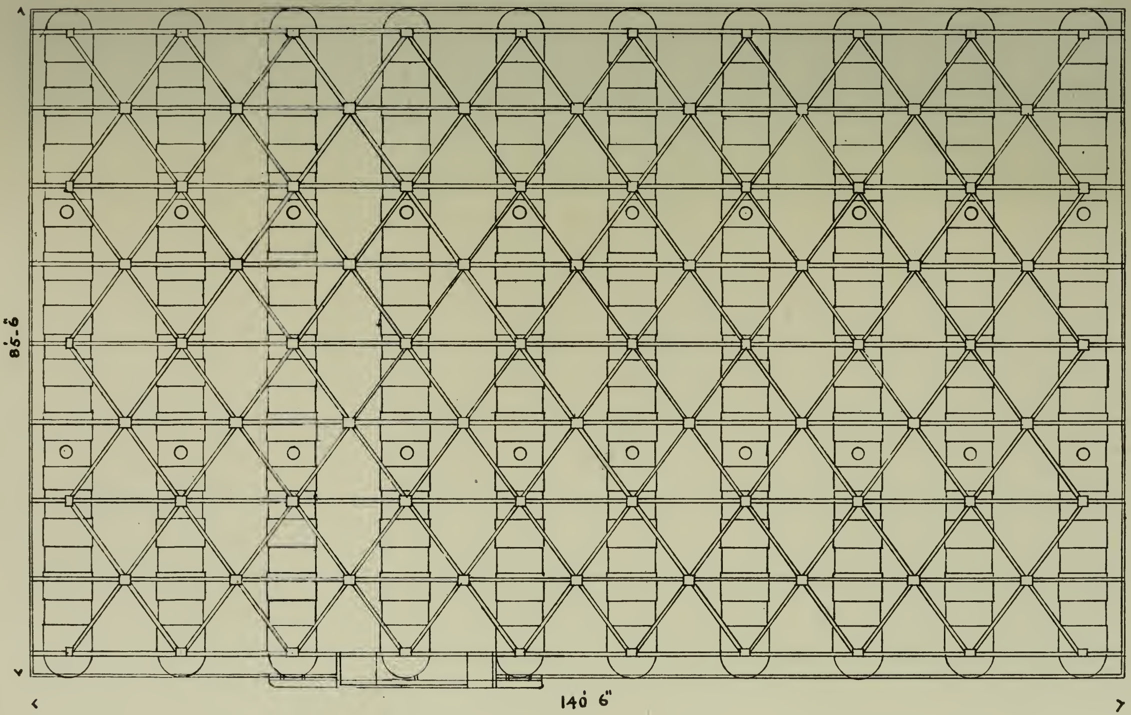
Fire and Lightning Precautions.

Provision has been made in case of fire by means of a number of portable fire extincteurs, hand grenades and hand buckets in all the blocks of buildings. A lightning conductor is also fixed to each building. A large boat fixed to davits is placed on the edge of the dock near the laundry block.

Lighting of Buildings.

As it is impossible to obtain a gas supply, the lighting of the wards and other rooms will have to be done by oil placed in suitable ships' lamps hung on pivots. A small lamp room properly fitted up is placed at the rear of the administrative block.

TEES FLOATING HOSPITAL.



Plan shewing Pontoons & Girders

DIAGRAM No. I.

PHOTO-LITHO. SPRAGUE & Co. LONDON.

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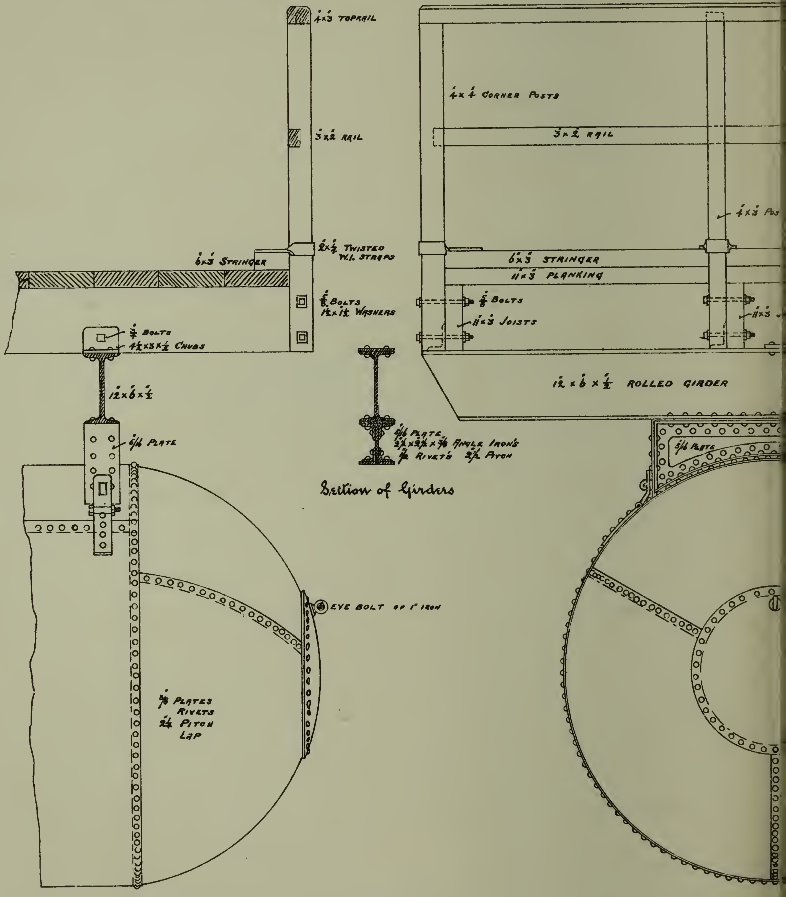
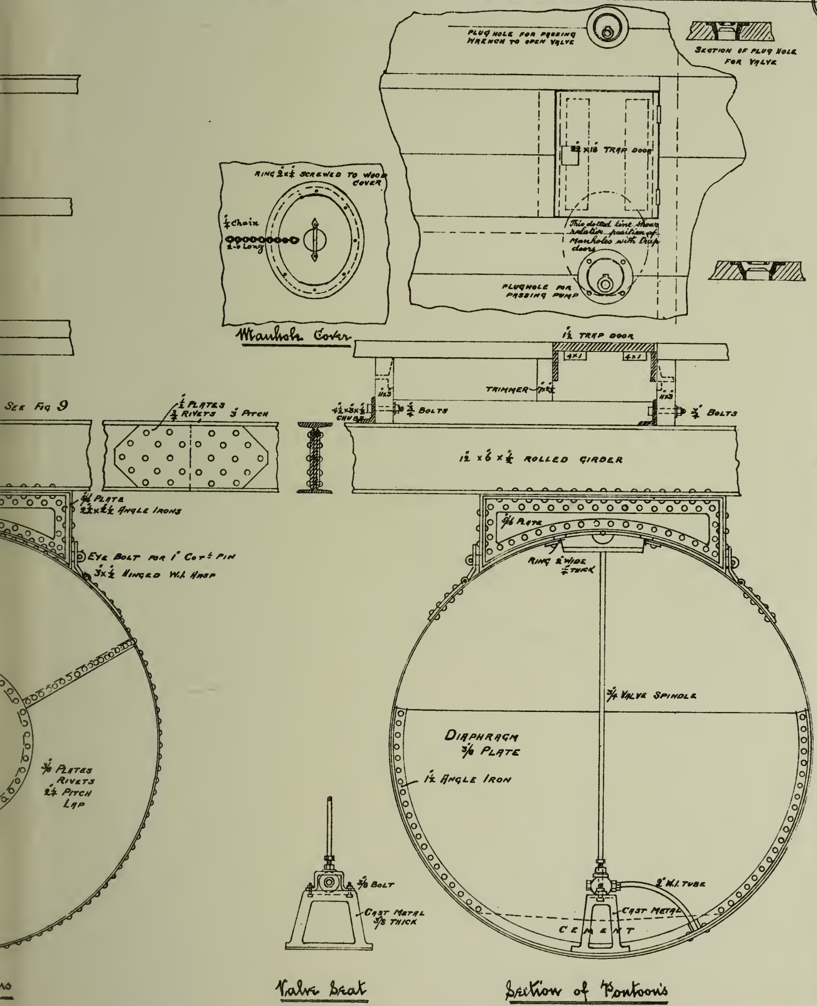
TEES FLOATING HOSPITAL. DIAGRAM Nº



Section of Girders

Elevation of End of Pontoon

End of



Manhole Cover

ns

Valve Seat

Section of Pontoons

PHOTO-LITHO. SPRAGUE & Cº LONDON.

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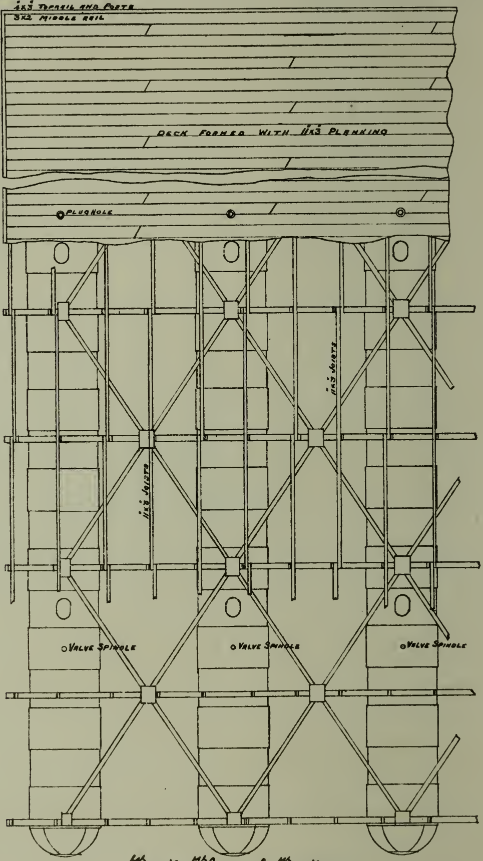
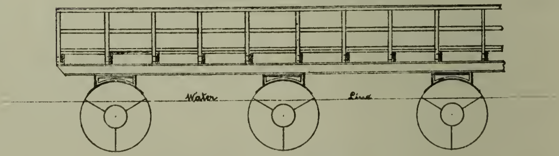
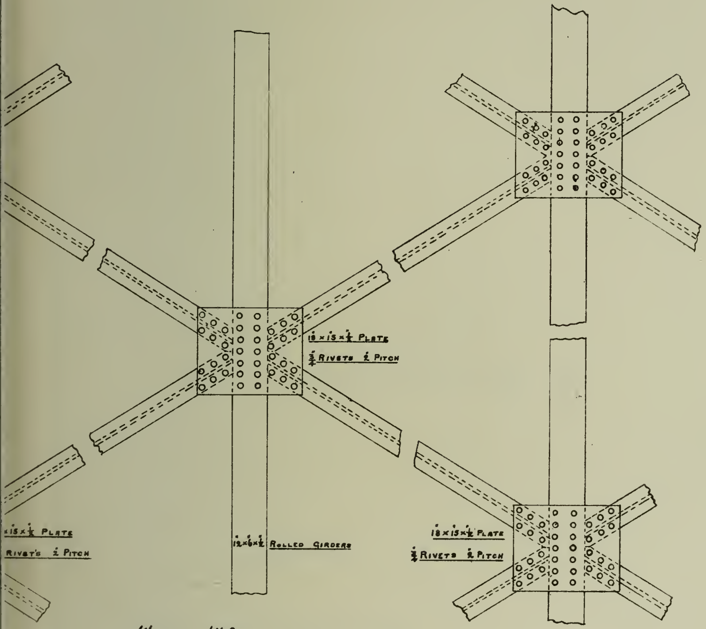


Part Plan of Pontoons

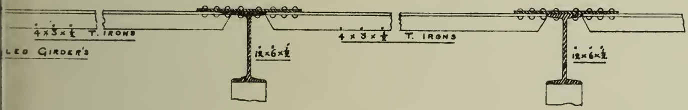


Part Elevation of Pontoons

TEES FLOATING HOSPITAL.



Part Plan of Bracing



Section of Girders with Bracing

DIAGRAM No. 3.

PHOTO-LITHO. SPRAGUE & Co LONDON.

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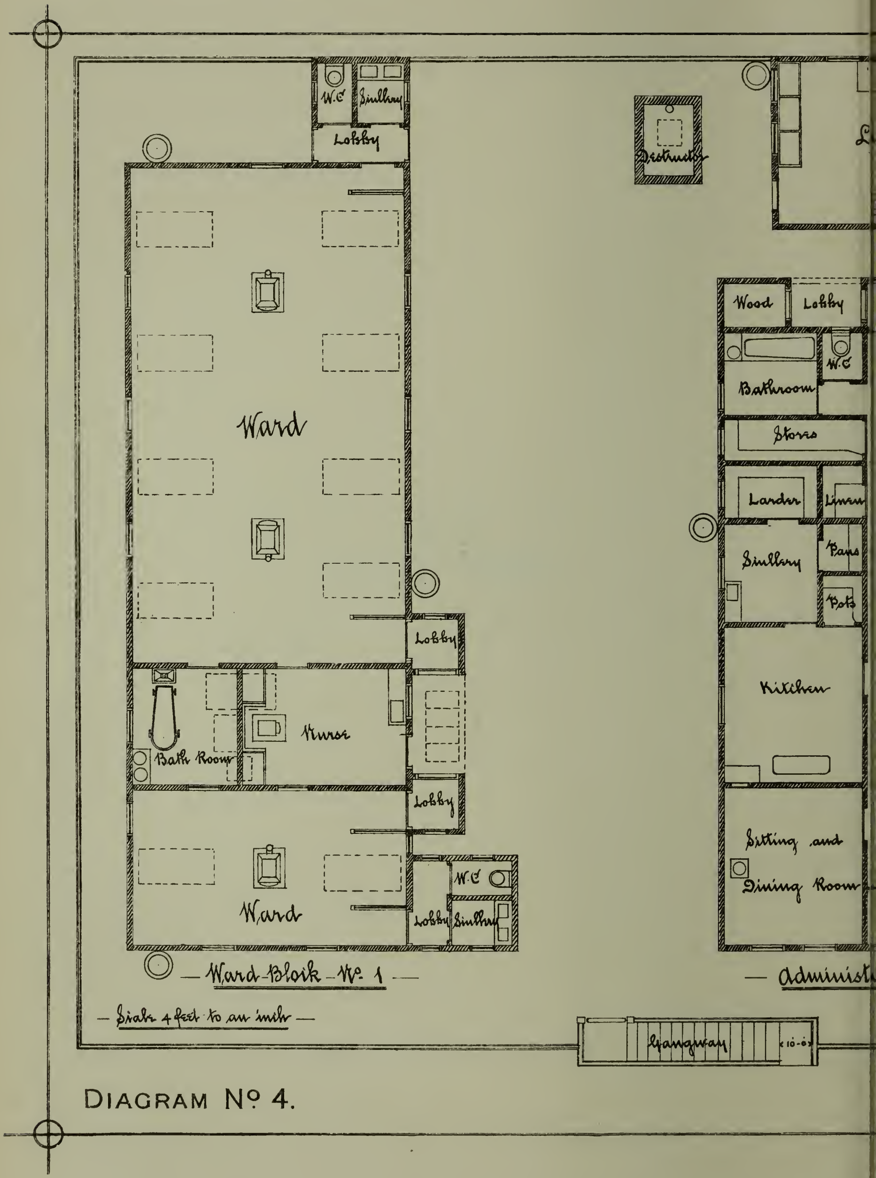
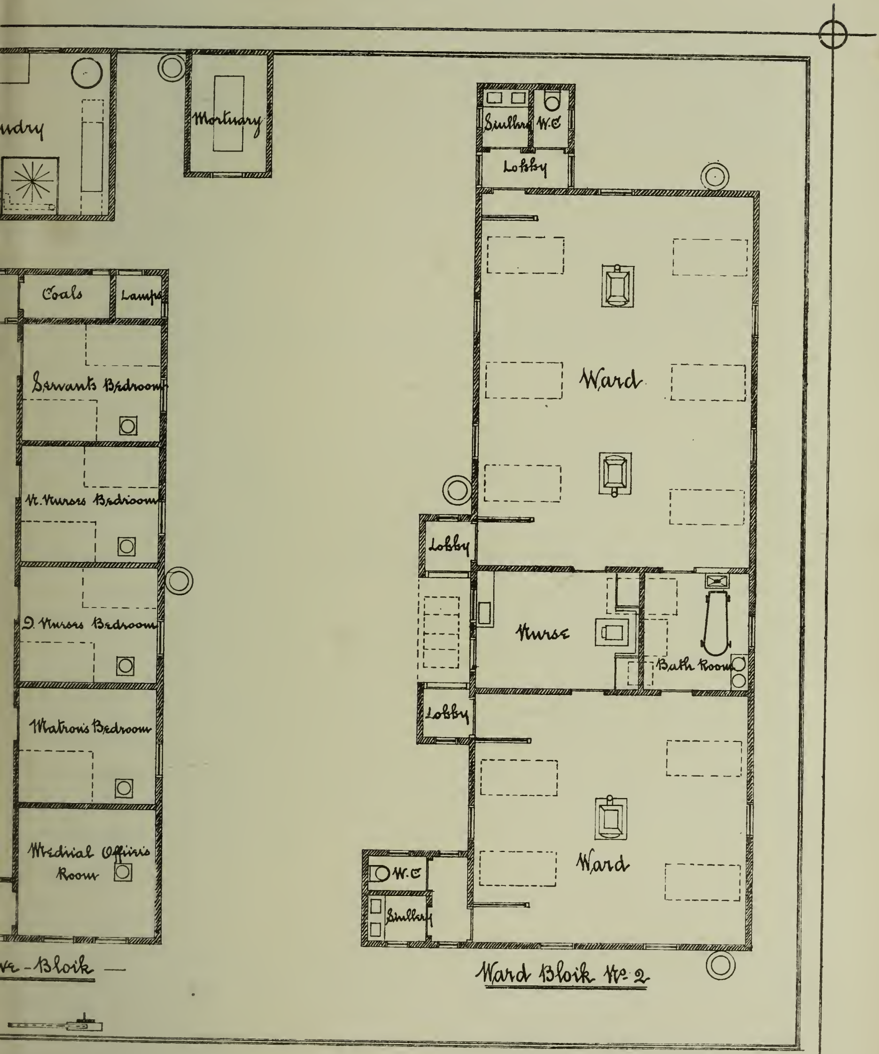

W.C
Scullery
Lobby
Destructor
Ward
Nurse
Bath Room
Lobby
Lobby
W.C
Lobby
Scullery
Ward
— Ward Block No 1 —
— Scale 4 feet to an inch —
Gangway
10-0
Wood
Lobby
Bathroom
W.C
Stores
Larder
Linen
Scullery
Pans
Pots
Kitchen
Sitting and Dining Room
— Administ

DIAGRAM Nº 4.



TEES FLOATING HOSPITAL.

PHOTO-LITHO. SPRAGUE & Cº LONDON.

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Space per Bed.

The total cubical area in the wards is 38,246 feet, and the superficial area is 2574 feet. This gives an average of 1912 cubic feet and 128 superficial feet for each patient, which is slightly less than the Local Government Board's requirements for fever hospitals built on land.

Cost.

The cost of the hospital and the works in connection therewith has been as follows:—

Dredging for berth	£3,000
Mooring chains, piles, &c., pontoons and deck, ward and administrative blocks, laundry, mortuary and destructor	7,000
Total	£10,000

The contractors were Messrs. Head, Wrightson & Co., of Thornaby-on-Tees, and the following firms acted as sub-contractors, viz.:—Anderson, Anderson & Co., Thornaby-on-Tees, for joiners' and carpenters' work; R. Hind and Son, Stockton-on-Tees, for plumbers' and glaziers' work; W. C. Allen, Thornaby-on-Tees, for painters' work. All of these carried out their several portions of the works in a highly satisfactory and workmanlike manner, and the result of their labours has been the construction of one of the finest floating hospitals in the kingdom.

The author has acted jointly with Mr. W. G. Laws, M.Inst.C.E., as engineer to the Tees Port Sanitary Authority; and also as resident engineer during the construction of the hospital—an arrangement that has proved satisfactory to themselves and, they hope, to the authority.

DISCUSSION.

The President: The admirable paper read by Mr. Stainthorpe, describing the floating hospital, is now open for discussion, and any Member who wishes may now ask any questions respecting the construction of the hospital. Personally, I would like to congratulate the joint engineers upon the result of their labours, and note with satisfaction the use in the hospital of Musgrave's stoves, Kite's inlet ventilators, Hartley and Sugden's harness-room boilers; Goddard, Massey and Warner's destructors; Shanks's safety wash-out closets, and Bradford's laundry apparatus; all of which are well known to Members of the Association. The hospital appears to be admirably designed and beautifully fitted up, and is a credit to the Tees Port Sanitary Authority.

Dr. MALCOMSON (Medical Officer of Health, Middlesbrough): I first wish, on behalf of the Tees Port Sanitary Authority, to welcome you to our new hospital. I have struggled for a good many years to obtain a sanitary hospital for the river. I believe the whole district is indebted to Mr. Laws and to Mr. Stainthorpe for providing one of the best hospitals in the kingdom; in fact, I do not believe there is another port hospital like this in the world. I am very pleased the Association of Municipal Engineers have visited Middlesbrough to see what we can do for sanitary science in this part of the country. You are all engaged in somewhat similar work to myself, so you know how we are hampered in our work by the word cost. This hospital has cost the Authority a good deal of money; but it is well expended money if it secures us against the importation of disease. The full effects of disease are not represented by the number of deaths; the deaths represent only about 10 per cent. of the sickness, suffering, hardship and other evils brought upon the country by disease. No money which can be spent is too much to spend to prevent sickness which is preventable. I am very glad to say that the Tees Port Sanitary authority is an up-to-date authority, and is doing its duty to sanitary science.

Mr. J. W. BROWN: There are one or two points upon which I should like further information from Mr. Laws. First, with regard to the heating of the hospital. I cannot help thinking that the system adopted here is not quite the best. Musgrave's stoves dry the air of a room too much, and my fear is that it will make it too dry to be agreeable to the patients. I think if it were treated with hot-water radiators it would have been more satisfactory. Then, again, as to ventilation. The old system of ventilation has been adopted, I notice. The mode of ventilating immediately under the head of the bed I do not think a good one. I should not like, if I were ill, to lie immediately over one of the ventilators. The system of Tobin's tubes, carried up 6 feet or 7 feet high, and discharged into the wards, would be superior to the system adopted. I notice that angle beads have only been put in at the angles of the floors and walls. They ought to have been put in at all the angles. Then with regard to the lavatory basins, I do not think they are the best kind for a hospital. The basins have containers.

If the basins had discharged into a trapped pipe they would have been more cleanly. Then there appears to be no accommodation for bathing the patients. I saw a portable bath in the ward, and have been told that when a patient needs a bath it is intended to draw a curtain round the bed. But when a patient is convalescent and is leaving the hospital for the town, he should have a bath before leaving the hospital.

Again, I wish to put a question similar to what I asked at Newcastle-on-Tyne, when Mr. Laws was good enough to read a paper on the hospital there. What accommodation is there for females? Supposing a boat comes in from Hamburg with several females stricken with disease on board, what will you do with them? I think there should be some separate accommodation provided for females. I think the hospital a most excellent building, well designed and well carried out, and reflects the greatest credit on everybody concerned.

Dr. Watson: In the closets at the end of the wards there does not seem to be any provision for cross ventilation, and as they seem to be fitted with windows on each side I think cross ventilation ought to have been provided; otherwise I think this building a credit to the Tees Port Sanitary Authority.

Mr. Crummack: I think angle beads ought to have been put in all the corners, because it is important in an infectious hospital where disease germs are likely to creep into every crevice.

The Rev. J. J. Nolan (Grangetown): What parish is this hospital in, and where will the dead be buried?

Mr. Anderson: You had better ask the question of the Tees Port Sanitary Anthority.

Mr. Brown: I think it is a very pertinent question, and one which ought to be answered.

Mr. Anderson (addressing the President) said: From your position, Mr. President, it is utterly impossible for you to answer such a question. It certainly does not come within your duties as President of the Association of Municipal Engineers to settle a question which belongs to the many parishes of which the Port Sanitary Authority is composed.

Mr. Brown: I should like to ask whether the dead bodies will be cremated or buried by sea or land?

The President: I think the question is outside the limits of our discussion to-day. We are here to discuss the structure of the hospital, and not the burial of the dead.

Mr. Laws, in replying to the discussion, said : I will endeavour to reply to the questions in the order in which they were asked. First, with respect to the use of the Musgrave stove. We are fully aware that the Musgrave stove has its demerits, but we do not find, as a rule, the difficulty in these hospitals open to the sea air is want of dampness in the atmosphere; it is rather the contrary. We find these stoves work very well in other hospitals where we have adopted them. They seem to satisfy both the patients and the medical men. I have had no complaints, and I hope in this case they will be found equally satisfactory. The next question was as to the ventilators.

Mr. Brown: The objection was to the ventilators being placed immediately under the bed.

Mr. Laws: There again we tried to meet the wishes as far as possible of the medical officer, and he seems to be satisfied. With respect to the amount of draught being injurious to the patients, I don't know about that; I am inclined to think the nearer to the patient the better. Personally I always sleep with my window open, which is the most direct ventilation I can get. When you allow the air to come in under the bed it spreads out before it reaches the patient. The next question was as to the angle beads. We put angle beads where we thought them to be most necessary, where the brush is most applied, but we might have put them in the corners. The next question was as to the provision of separate bath rooms. I daresay you know perfectly well that the difficulty we are chiefly troubled with, after that of £ *s. d.*, is that of space. We cannot have all the refinements of a hospital on the shore; we get as many as we can in the space. I do not think, however, there would be any difficulty in a patient having a bath before leaving the hospital. With respect to provision for females, that is a question I have heard more than once. I think as a rule there are very few females ever need to go into these hospitals, although it is true there are some on the ships. I do not know that we have ever had an application on the Tyne, but if the necessity did arise we have a small ward which could be applied to this purpose. With respect to Dr. Watson's question, the louvres at the sides of the passages to the closets *are* provided for through ventilation. The fact is that ventilation here is not a difficulty; we have too much of it; the difficulty is to keep the wind out of the place. I think the louvres will be found effective without a heavy draught upon the patients when they leave the ward. As to the disposal of the dead, of course, I cannot touch upon that. I would like to add that gentlemen must not give me the whole credit of the design of this hospital. It is equally Mr. Stainthorpe's design. In fact, Mr. Stainthorpe has had as much to do with the arrangements of the wards as I have, and he has had more to do with seeing the work carried out than I have, and if you look round you will see the work is thoroughly well done. In the first place, we have had an energetic and enterprising Authority, and the question of £ *s.* *d.* has not been made too prominent. I have had an able assistant to carry out the work and a contractor who has done the work in first-class style. I have not a fault to find with the work.

The PRESIDENT: We have seen here a very admirable structure, but, as the late Robert Stephenson said when he was driving the last rivet into the Menai Bridge, "All my exertions are of no avail unless I have some one under me who can carry out the details, and workmen who can build up the structure." I think Mr. Laws has had very able assistance from Mr. Stainthorpe, the resident engineer, in the construction of the hospital. I am convinced that Mr. Stainthorpe must have earned the gratitude of the Tees Port Sanitary Authority for the admirable manner in which he has superintended the work. And he has to-day earned the thanks of the Members of our Association for taking us over the hospital and explaining everything to us so minutely. I am sure our thanks are due to him, and I ask you to accord those thanks by acclamation.

The vote of thanks having been accorded,

Mr. T. W. STAINTHORPE, in acknowledgment, said: As Mr. Laws put it, I am rather a worker than a speaker; but I may say this work has been to me a labour of love. I have tried to do my best, and I am proud and pleased to think that any little effort I have given to it has met with your approval. I would take this opportunity of thanking Mr. Laws, my colleague in this work. I hope every young engineer may have so kind and able a friend and adviser as I have had in Mr. Laws in the carrying out of this work. I can throw some light on the position of Kite's inlet ventilators to which Mr. Brown has made objection. I had to pay a visit to the Local Government Board, where I had an interview with Mr. Gordon Smith and Dr. Thorne respecting the plans and the ventilation of the hospital. Our ventilator inlets were designed on the Tobin system, but the officials of the Local Government

Board objected, and insisted upon the inlet ventilators being in the position in which you see them.

The President: We have had the assistance of the public authorities of Middlesbrough, who have kindly allowed us the use of the Council Chamber for our meeting this morning, and we are indebted to the Tees Port Sanitary Authority for permission to visit this hospital, and to the Tees Conservancy for the use of the steamer on which we came here. Without the assistance of the local authorities we could not have met here to-day, and I ask you to accord, in the most hearty manner possible, our thanks to the various Authorities for their kindness.

After the discussion on Mr. Laws' paper, the Members were entertained to luncheon by Mr. Laws at the Wellington Hotel. The Members then proceeded down the river on the steam launch "Osprey" to the floating hospital, where they disembarked and inspected the hospital building and fittings. After the inspection the Members assembled in the large ward of No. 1 *Block, where Mr. Stainthorpe's paper was read and discussed. The party then returned to Middlesbrough, where they were entertained at the Erasmus Club by Mr. Dent and Mr. Hutchings, the managing directors of the Scorier Brick Company, Limited, Middlesbrough.*

DISTRICT MEETING AT WESTMINSTER.

January 18, 1895.

Held at the Institution of Civil Engineers, Westminster, S.W.

A. M. FOWLER, PRESIDENT, *in the Chair.*

THE following papers were read and discussed.

PRIVATE DRAINS OR PUBLIC SEWERS.

BY W. NISBET BLAIR, Assoc. M. Inst. C.E.,
ST. PANCRAS.

THE present position of matters in regard to the above is doubtless a subject of interest to most of the Members of the Association, and it is probable the majority of us have had cases in which a decision has been given which inflicts upon the ratepayers a most serious burden, and one that we can only regard as a most inequitable, if not indeed iniquitous, charge upon the public rates. But the practical opinion of engineers and surveyors on this matter goes for little when it is opposed by legal opinions or, above all, by legal decisions, and doubtless we are agreed that it is eminently desirable that an alteration should be made in the law, or that some interpretation should be declared by Parliament, which would render it no longer possible to repeat the decisions that have been given on similar cases to those which have been before the courts during the last few years. There appears to be a difficulty as to how Parliament should be approached to bring about this change in legislation. The simplest means, so far as regards London, would be for the London County Council to bring in a Bill embodying satisfactory clauses, but, unfortunately, the Council having been approached by the local authorities of London is advised not to proceed with the matter.

The clauses in the Metropolis Management Acts of 1855 and 1862, which distinguish between what is a drain and what is a sewer, define that a combined drain to remain the property and at the liability of the owner must be made "under the order of the vestry or district board" as applied to drains made subsequent to 1856, and "pursuant to the order or direction or with the sanction or approval of the Metropolitan Commissioners of Sewers" as applied to drains made before the 1st of January, 1856, and it has always been held that the burden of proof, as to this approval or order, rests with the local authority, so that any combined drain made either before or after 1856, without notice being given to the local authority, or without the submission of any plan, or in fact surreptitiously and illegally, becomes, by virtue of the very illegality of its construction, a sewer, and as such is chargeable upon the public rates. From the experience of the author in a London parish he has no doubt there are many thousands of such cases in London. Judging from those which do come under the notice of the authority from time to time, it appears to be quite obvious why the person, who originally constructed the work improperly, did not notify the Local Authority; had he done so his work would doubtless have been done differently and his pocket would have suffered.

An illustration of a case of this kind may be found in the case of Moss and the St. Pancras Vestry, which came before one of the metropolitan police courts in October last, and of which a plan is appended, Fig. 1. The Vestry's contention before the Bench was that the pipe passing through the house from the main sewer was a drain, as, though no approval could be traced to the connection of the two pipes from the adjoining house, it was contended that such connection had been made surreptitiously and that such an act should not render the Vestry liable to maintain the pipe passing through the house as a public sewer; but as the burden of proof was on the Vestry to show that it did not give its sanction to the laying of the drains, and having failed in that, the summons was dismissed. One can understand that it is not difficult for a local authority to show that approval was given where such was the fact, but to prove that consent was not given to work of which it had probably no cognisance, and where no approval was asked, is certainly a very severe handicap upon a local authority, and the unavoidable result is, that the rates are charged with the cost of making good the defaults of private individuals.

This plan raises a question upon a theory that has been advanced, namely, "once a sewer, always a sewer"; for by laying a drain from the sewer through No. 225 to take the whole of the drainage of that house, the pipe through No. 227 would then only take the drainage of one house, and under the definitions given in the Statutes it would be a drain. The question therefore is, whether, seeing that this pipe while taking the drainage of two houses was a sewer, and having altered that arrangement so that it only takes the drainage of one house, is it still to be regarded as a sewer? Arising from this it might be asked whether a pipe "once a drain is always a drain"? A case came under the notice of the author some time ago where property consisting of a large house, garden and outbuildings, originally all in one occupation, had become unsuitable, by change in the character of the neighbourhood, to continue so let, and was occupied as three tenements, each having separate access, but still all drained by the original drain, which took everything from the premises by one connection with the sewer. This drain at the time of construction drained only premises in one occupation, but by subdivision of the premises into three occupations, it had, without any alteration to itself, become a sewer.

Another illustration of combined drainage is given in Fig. 2.

Another difficulty which may arise—in fact, which has arisen in one case—is in the identification of property now existing with that shown in a plan approved nearly fifty years ago.

Fig. 3 shows certain property upon which defective drains were found to exist on the lines indicated, and on searching the records of the Commissioners of Sewers, nothing could be found of the property under its present address. It happened, however, that a gentleman with a very long memory was looking through a list of the approvals given by the Commissioners of Sewers, which had been abstracted so as to show all the cases within the limits of the parish, and among which was only one plan showing the combined drainage for which the approval of the Commissioners had been obtained. This plan naturally attracted attention and was recognised as giving the original names of the streets shown in Fig. 3.

The Commissioners' approval was given, in 1849, to the drainage of the property shown on the plan (Fig. 4), by a combined operation, and though the lines of the drains thereon shown do not correspond with the precise position of the drains as now discovered, still the principle approved had been adopted and carried out, and consequently the whole is still a system of combined drainage, and its reconstruction could not be charged to the rates.

There is another question upon which difference of opinion exists. A branch from a main sewer may receive the drainage from property in more than one occupation, and is consequently a sewer; but a certain distance along its course a junction exists above which the drainage is divided. This is illustrated in Fig. 5, the combined drain being shown in black and the two drains above the junction in blue and red. That shown in red takes the whole of the drainage of the property through which it passes, but of no other property, while that shown in blue passes through the property without taking any of its drainage, as it is required for other property in other occupation, at the rear of the property passed through, and adjacent to which no available sewer exists, so that one property is subject to an easement for the drainage of the other. The question is:—Are either of the drains shown in red or blue to be regarded as sewers? The author's contention is that each is a drain, whereas he is aware that a solicitor has advised that both are sewers, for, as the connection at the sewer takes combined drainage and is therefore a sewer, it is alleged that no distinction can be made on different lengths of the same channel, and that all must be a sewer. If so, then every soil pipe which may be connected to a combined drain becomes a sewer, though passing vertically through a private house, and a rain-water pipe taking water from the roofs of a row of cottages becomes a public sewer.

There is also a point of some interest, namely, to distinguish between what is a new drain and what is a repair, and the author has met with a contention that a repair only was being executed where the whole of the drains around the house were relaid, largely on new lines, but the reconstruction ceased at a point a few feet within the garden wall which abutted upon the public road, and the length of drain under the road was not disturbed. In this case it was urged that no plan was necessary, nor could the owner be required to carry out the work in accordance with the vestry's regulations applying to new drains.

The reports of the law officers of the London County Council will afford some interesting study to the Members of the Association, and the author does not feel able to leave the subject without referring shortly to these reports which suggest that the difficulty in which the local authorities are placed is due either to their own imperfect comprehension of the law as to drains and sewers until it has recently been made clear in the law courts, or that their difficulty is due to their own laxity of supervision or neglect in keeping proper records of combined drains sanctioned by them. It is admitted that other causes may arise in consequence of the impossibility to extract, from the orders of the Metropolitan Commissioners of Sewers, proper evidence of identification, so that the result is that no doubt many drains, which ought still to be drains, have now to be considered as sewers and treated and repaired as such. It is also suggested, that as the representations to the Council have only been made by some of the vestries, the difficulty exists only in some of the parishes or districts, and does not affect all parishes equally, and that this may be due to the laxity of the local authority or their officers or their predecessors to a greater extent in some districts than in others, and that any expense incurred in promoting legislation which would be charged to the county rate would involve some districts contributing for the benefit of others which have been in default, and *that this in itself is a sufficient reason against the Council concerning itself in the matter.* There are few, who really understand the present difficulties, who will agree that the culpability suggested as resting upon the local authorities or their officers for laxity of supervision or system is the cause of the present position of things, nor is this a proper occasion to fling back these allegations.

So far as the parish of St. Pancras is concerned the author is able to say that it has a record of every drain that has been interfered with, with the knowledge of the Vestry, since the constitution of the Vestry in 1855 ; and unless an authority is informed that work is contemplated it is certainly not to be blamed for not supervising any work which may be done surreptitiously, and surely the laws of the realm, which, it is boasted, are based upon common sense, are not to be twisted in order that a person may benefit by his own wrongdoing. This is an axiom of old standing and general acceptation, but it seems to have been ignored in some of the recent decisions ; the letter of the law may be observed, but no one can reasonably suppose that such was its intention.

The present may be an opportunity for bringing about what the author considers a reform in regard to the execution of all such work. By the Act of 1855 it is required that all new drains shall be laid under the direction and to the satisfaction of the surveyor of the vestry or board, and as the Public Health (London) Act, 1891, does not deal with drains in any way, and consequently does not vary the intention of the original Act, the author contends that the surveyor is the proper officer to supervise all drainage work, whether it be the construction of new drains or repair of existing drains. The extreme popularity of the subject of sanitation has during recent years raised the sanitary inspector into an important officer, but it is the author's opinion that his proper functions do not extend to the supervision of drainage work, nor do his training and experience render him better qualified for such supervision than the officers of a surveyor's department with the surveyor as the responsible chief.

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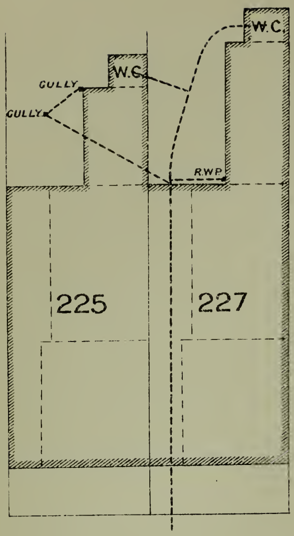


Fig. No 1.

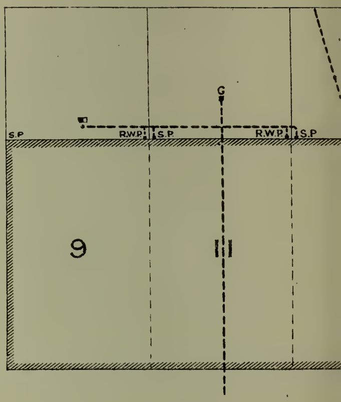


Fig. No

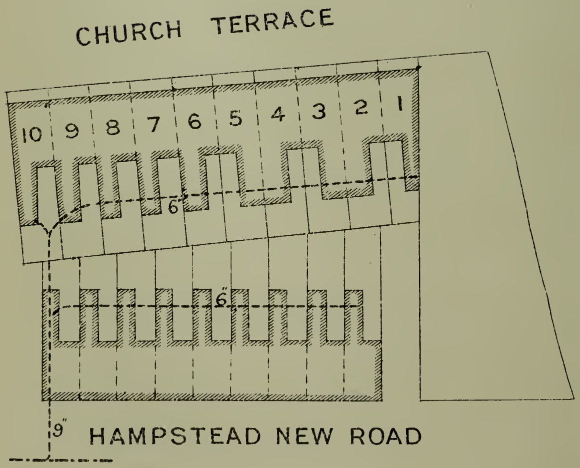
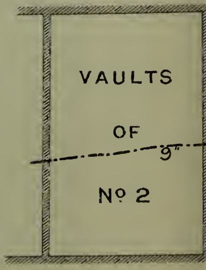
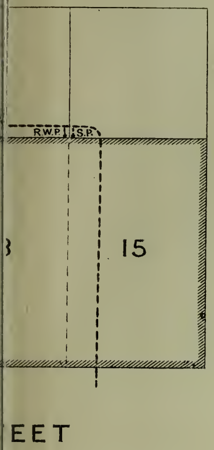


Fig. No 4.





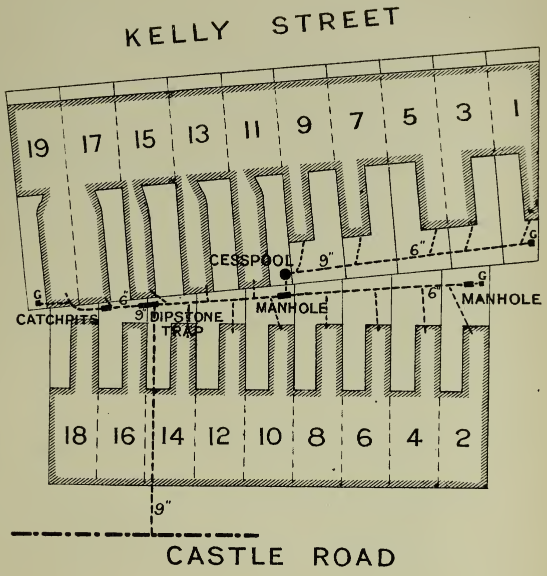


Fig. No 3.

DRAIN AT 5 CHESTER TERRACE

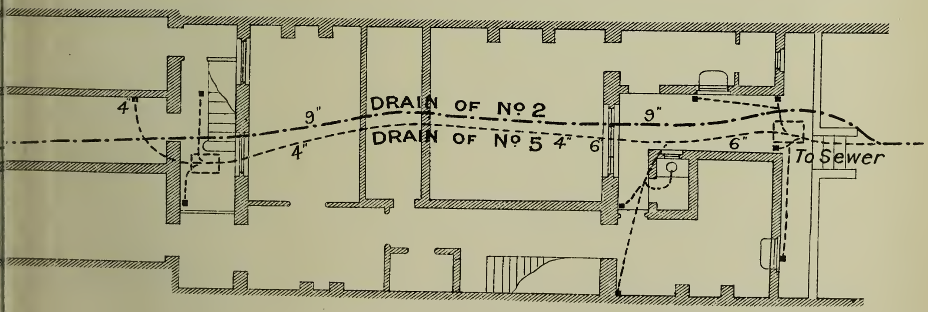


Fig. No 5.

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NOTES ON COMBINED DRAINAGE.

By ROBERT GODFREY, Assoc. M. Inst. C.E., Rural District Council of King's Norton.

In undertaking to bring the subject of Combined Drainage before the Members of the Association, some explanation is necessary as to why a provincial Member should address a meeting of London Members.

Under the Metropolitan Management Act, 1855, section 250, it appears that combined drainage is authorised "with permission," and that, therefore, in the future all combined drains can be kept from becoming sewers; but in the Public Health Act, 1875, amended in 1890, there is no provision of that kind, and therefore the interpretation of the Courts, as focussed by the case Travis *v.* Utley, has a far more serious effect on provincial districts than on metropolitan vestries (Diagrams Nos. 1 and 2). And as it is generally conceded that some alteration in the law is required, the writer may be excused on behalf of his provincial brethren for bringing the matter before this metropolitan meeting, and in asking the aid of the Association in the endeavour to bring such pressure on the Local Government Board as will lead to an amendment of the law, whereby local authorities shall be relieved from the enormous burden cast upon them.

It appears to the writer that the cause of the trouble has arisen from a too cursory reading of the definition of the word drain in section 4, Public Health Act, 1875. "*Drain* means any drain of and used for the drainage of one building only," or "premises within the same curtilage." The rock on which we have come to grief is the word *curtilage.*

Tomlin's Law Dictionary says the word is derived from the French *cour* (*court*) and Saxon *leagh* (*locus*), and it is described as "a courtyard, back side, or piece of ground lying near and belonging to a dwelling house."

Transition of thought has added to this the idea that not only does the word imply *court place,* but the boundary or fence enclosing such *court place,* and therefore we may possibly be excused for attaching to the word a more extended meaning than that which is philologically due to it. Other dictionaries give the meaning as follows:—

The Imperial: A yard, garden, enclosure or field near and belonging to a messuage.

Webster: A yard, courtyard or piece of ground pertaining to a dwelling house, and included within the same fence.

The Century Dictionary: In law, the area of land occupied by a dwelling and its yard and outbuildings, and inclosed or *deemed as if inclosed* for their better use and enjoyment.

See also *Stroud's Judicial Dictionary* and *Jacob's Law Dictionary.*

In *Commissioners of Inland Revenue v. Goodfellow* (45 J.P.) it was held that a meadow adjoining the garden of defendant and in his occupation was not within the curtilage.

Shepherd's Touchstone, vol. i.: Curtilage is defined to be a little garden, yard or field, lying near and belonging to the messuage.

Stephen's Commentaries on Blackstone, vol. iv.: No building, although within the same curtilage with the dwelling house and occupied therewith, shall be deemed to be part of such dwelling house, for the purpose of burglary, unless there shall be a communication between such building and dwelling house.—7 & 8 Geo. IV. c. 29, s. 13.

Curtilage is defined in several Acts with reference to burglary, before drains were invented.

Lord Justice Rigby's remarks on the word Curtilage:—"He thought that the word 'curtilage' was never applied to anything which was common to more than one messuage. The idea of something belonging to a dwelling house seemed to run through all the definitions which had been given of the word. In his opinion there was no authority for treating 'curtilage' as equivalent to ring fence or boundary. The element of smallness was no doubt one matter to be considered, but it was by no means the most important thing. He thought that in considering the meaning of 'curtilage' the main distinction to be drawn was that between a plurality of messuages and a single messuage. Here there are at least two messuages, viz. the two blocks of buildings. If one of the blocks were conveyed separately, no doubt an easement might be created with regard to the use of the causeway, but the causeway could not be considered any part of the curtilage of that block. He therefore thought that on the construction of Section 250 of the Metropolis Management Act, these were not premises within the same curtilage. It appeared to him that the present case was governed by the Lowther Arcade, the legal incidents of the two cases being the same."

From these definitions it is clear that the proper use of the word curtilage is that adopted by the judges, and that its application to the *boundary* of a property containing more than one dwelling is not warranted by the derivations and meaning of the word. The word messuage in law is well understood, and therefore a curtilage cannot be common to two or more dwelling houses. Consequently, a builder erecting a terrace of houses on what was one messuage, not only creates messuages but also creates as many curtilages as houses, though they may not be separated, and so far the decision of the Courts (with one exception, the Shoreditch case) are in harmony with the definition.

The draughtsman of section 250, Metropolitan Management Act, 1885, evidently seems to have grasped the position better than we have done, and provided for the combination of these curtilages by permitting "any drain for draining any group or block of houses by a *combined operation* under the order of any vestry or district board." Section 74 of that Act empowers the vestry or district board to order a combined operation, but unfortunately for many of the London vestries that Act is made to apply retrospectively, and is making the vestries responsible for drains which were put in before the vestries, &c. were called into existence.

In the case of the provinces there is no corresponding power given by the Public Health Act, 1875, and Mr. Justice Kay was perfectly right when he said, in the case of Acton Local Board *v.* Batten, "a drain is a sewer as soon as more than one house has been connected with it."

The Public Health Amendment Act, 1890, reveals a curious anomaly. In section 19 (3) it says, "For the purposes of this section the expression 'drain' includes a drain used for the drainage of more than one *building*," and Macmorran's note to this sub-section is as follows:

"The provisions of sub-section (1) and of this sub-section make the word 'drain' applicable to a drain which receives the drainage of two or more houses belonging to different owners." Thus directly contradicting the definition of the original Act, 1875.

"Such a drain would formerly have been a sewer, and as such, vested in and repairable by the local authority, and there was not such a thing as a single *private* drain of this kind" (i. e. used for the drainage of more than one building), "if the word *private* means not vested in the local authority." And the anomaly is that if a drain is used by two or more houses belonging to the same owner *it is a sewer*, but if the houses belong to different owners it may be a drain.

We are thus placed in the position that we must either insist upon every house having a separate drain, at no matter what cost to the owner, there being no authority for combined operation in the Public Health Act, 1875, or we must accept a drain, draining two or more houses, as a sewer—a condition of things of which we cannot gauge the potentialities.

By the kindness of one of our Vice-Presidents, Mr. E. R. S. Escott, the author is enabled to show a plan and section of the *locus in quo* in the case Travis *v.* Utley, from which it will be seen that there is no "curtilage" as defined above. The drain was laid under the floors of the houses, as shown, and the Court of Appeal held that this drain is a sewer, for which the local authority is responsible, as it drained more than one building. The author cannot see that any other decision could have been arrived at, though it is to be confessed that almost every Member of the Association would in all probability have been inclined to hold that this block of buildings was within the same curtilage.

The words of Mr. Justice Wright fully set out the difficulties of the case. In his judgment he says:

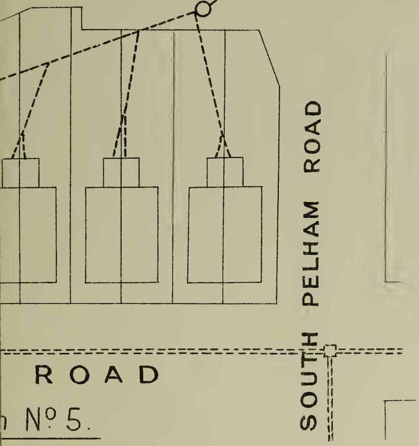
"To hold that what is really a private drain vests as a sewer in a local authority, is to hold that a local authority can take away part of a man's land in order to perform its functions, and also is liable for the cost of keeping private property in repair—two apparent absurdities."

Mr. Mason, of St. Martin's Vestry, has very kindly furnished a plan of the Lowther Arcade, which has been before the Courts as recently as December 18, 1894, and when again the vestry has not been able to maintain its position (Diagram No. 4). In this case almost every one would have treated the ground enclosed by the broad black line as the "curtilage," and that the one curtilage held a number of separate dwelling houses; but on recalling the definition of curtilage it seems that the Court of Appeal has correctly interpreted the definition in section 4.

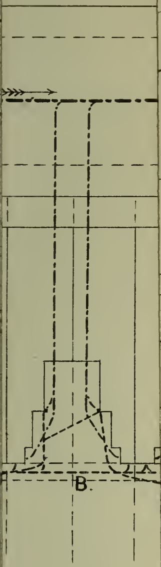
In the case of Pilbrow *v.* Vestry of St. Leonard's, Shoreditch, the Court of First Instance decided in favour of the Vestry, that the

T COWES LOCAL BOARD.

1892.

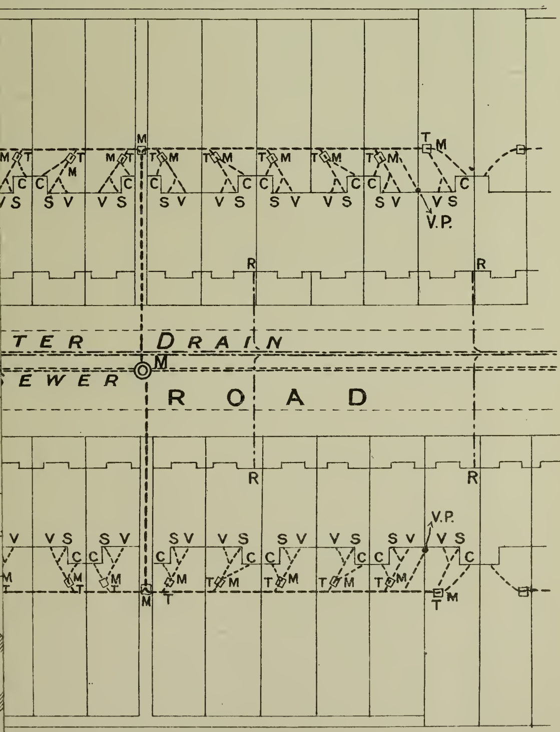


n Nº 5.



gram Nº 3.

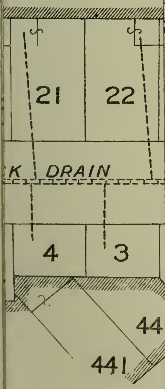
AINAGE OF TERRACE HOUSES.



M.& T. *MANHOLE & TRAP.*
V. P. *VENTILATING PIPE TO SEWER.*
R. *RAIN WATER PIPES*

n Nº 6.

DRAINAG



TRAVIS V. UTLEY

Nos 105, 107, 109, FERN STREET, BOOTHTOWN, HALIFAX.

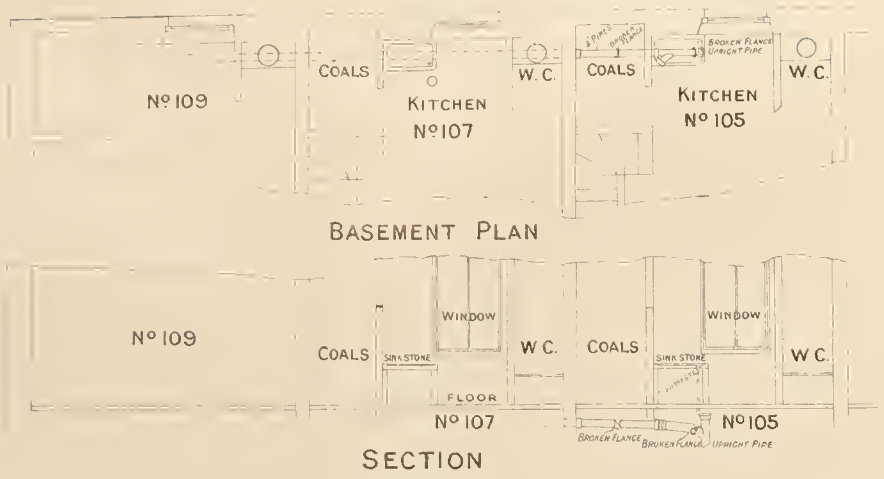


Diagram No 1

TRAVIS V. UTLEY

Nos 105, 107, 109, FERN STREET, BOOTHTOWN, HALIFAX. 1894.

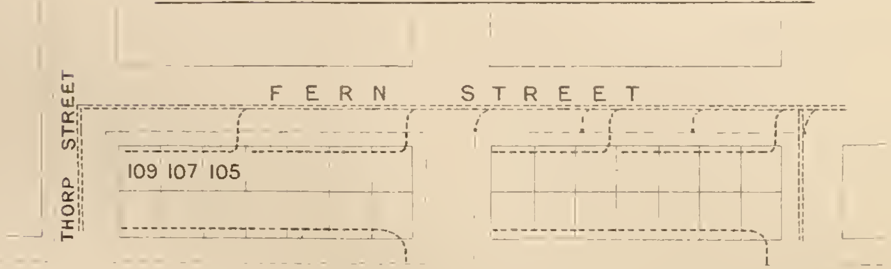


Diagram No 2

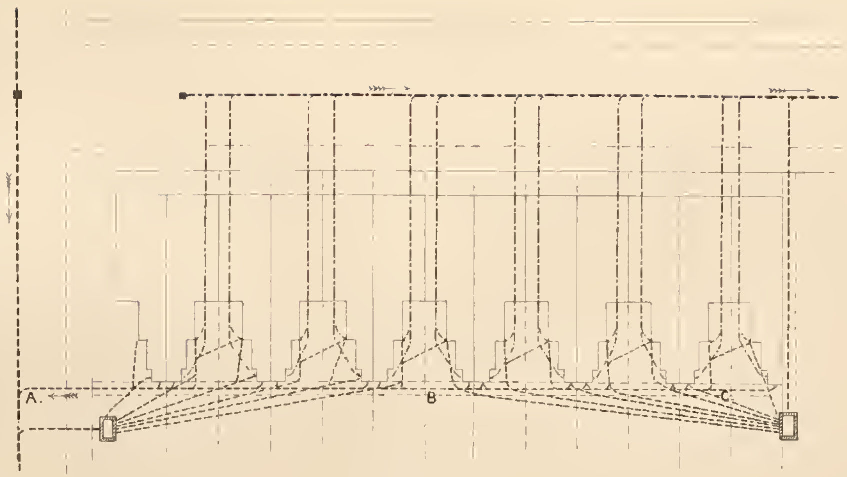


Diagram No 3

LOWTHER ARCADE DRAINAGE

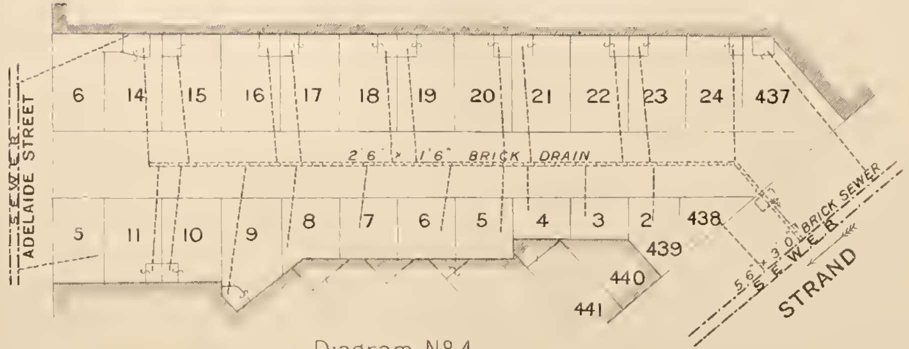


Diagram No 4.

MEADER V. WEST COWES LOCAL BOARD.

1892.

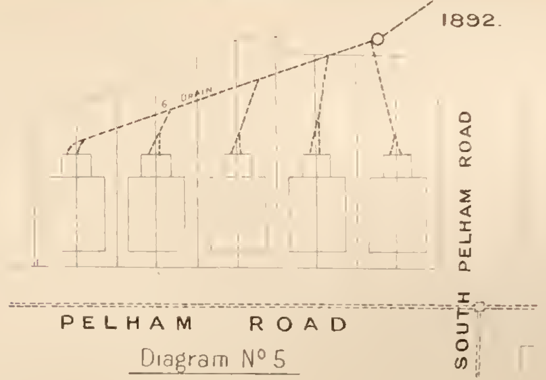
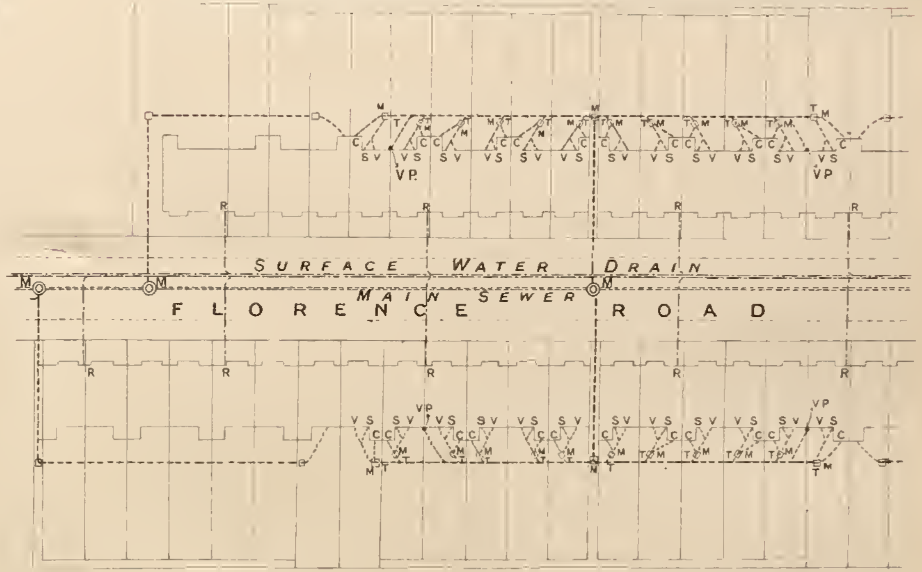


Diagram No 5

PLAN SHOWING BACK DRAINAGE OF TERRACE HOUSES.



C. WATER CLOSET
S. SINK GULLEY
V. VENTILATOR TO HOUSE DRAINS
M & T. MANHOLE & TRAP
V P VENTILATING PIPE TO SEWER
R RAIN WATER PIPES

Diagram No 6

drain in question was a combined drain, and the Court of Appeal, Matthews and Charles (JJ.), confirmed the magistrate's decision. Judging from the description of the *locus in quo*, it looks as if it was a second case of the Lowther Arcade, and hence the apparent contradiction in the judgments.

Accepting the fiats of the Courts above until the Public Health Act, 1875, can be further amended so as to sanction a "combined operation," as in sections 250 and 74 Metropolitan Management Act, 1855, the only course open to provincial authorities is to insist upon every house having a separate drain. This course has been adopted at Cardiff, West Bromwich and by the King's Norton Rural District Council, while Reading in its private Act has obtained the necessary power to order and sanction combined operations. The adoption of this course will lead to some curious networks of drains, especially in the case of terraces of small houses.

Where the minimum amount of air space, 150 super. feet, is provided for a row of, say six houses, there must be one of two conditions, as shown on Diagram No. 3. Either each house must have a drain underneath it, a condition forbidden by the model byelaws except in rare instances, or the curtilage of the house nearest the sewer must have a network of five drains from other houses under its surface; and the "inspection chamber" must be adapted to the number of connections which are to be made into it.

The local authority must accept the responsibility of that portion between the sewer and the inspection chamber, and must see that the various connections made to it are well and truly laid.

Further, the Local Government Board must be urged to extend the powers of the local authorities in the direction of prohibiting any interference with any private drain, under any circumstances, nor should any so called "practical man," be allowed to do anything to a private drain without notice having been given to the local authority.

A drain which was originally a private drain may be converted into a sewer by a "practical man" surreptitiously connecting the drain from another property to it. At present the control of the local authority over private drains ceases as soon as the work of laying them is passed, but there is nothing to prevent the owner or occupier altering or diverting them as soon as the house is occupied.

The light which the legal luminaries have cast upon this subject exposes another serious aspect of the case. If the local authority is to be responsible for and maintain a sewer from the main sewer to the inspection chamber, does it not become the duty of the local authority to provide and lay down that sewer?

Section 15, Public Health Act, 1875, says very emphatically: "Every local authority shall cause to be made such sewers as may be necessary for effectually draining their district for the purposes of this Act," and it is a question whether a builder could not call upon and compel the local authority to make such portion as is common to a group of houses, as A to B, Diagram No. 3. This raises the further question of entry on lands, and the contingent claims for easement, as well as the claim for surface damage in the event of any repairs being necessary.

Another point arises with regard to the disconnecting syphon. Any authority which puts or allows to be put syphons in a sewer, assists in forming obstructions in that sewer. Yet, as we have read the law, every combined operation in the provinces, such as that illustrated on No. 3, has had a syphon between the sewer and the messuage drained, and it is a well-known fact that scores and hundreds of these get choked, and cause a trouble which has to be dealt with by the authority.

If the method of dealing with a terrace, shown on No. 3, is adopted, there must be no syphon between the sewer and the inspection chamber, but a syphon in each drain, near the house; and to prevent the inspection chamber acting as a ventilator it must be kept closed, and an air shaft carried from it to the roof of the nearest building. This would avoid many complaints of the nuisance from sewer gas, and would materially assist in the ventilation of the sewers in a manner which would be void of offence.

Mr Lewis Angell suggests that the first line of section 19 (1), Public Health Amendment Act, 1890, should read, "where two or more houses belonging to *the same or* different owners," &c. The addition of the words *the same or* would avoid the anomaly pointed out above.

As the subject is one which is exercising the minds of all municipal engineers, who are practically unanimous in the view that some alteration in the law is necessary, this Association should, in the interests of the country generally, take the lead in an endeavour to bring such pressure to bear on the Local Government Board as will bring about a speedy revision of the definitions of drain and sewer, and so to relieve the already overburdened rate-payer of an enormous charge, which rightly belongs to the property owner.

The lines on which amendment should follow are:—

1. The Public Health Act, 1875, to be so amended as to sanction "combined operations."

2. Power should be given to prevent any alteration of drains without notice.

3. The words "*the same or*" to be inserted in section 19 (1), after the words "belonging to."

For the convenience of Members a list of cases and decisions is appended bearing on the subject of drains and sewers, collected from various sources, but which is far from complete; and the author would ask any Member who has knowledge of cases not in the list to favour him with particulars, to enable him to make it as complete as possible for reference in our volume of Proceedings.

METROPOLITAN CASES.

Vestry of St. John, Hampstead, v. *Hooper.*

June 30, 1885. (L.R., Q.B.D., vol. xv. p. 652.)

Vestry recovered cost of making branch drains from forecourts to sewer in a "builder's road."

Vestry of St. John, Hampstead, v. *Cotton.*

Appeal Court, December 18, 1885.

Vestry had made a sewer in a road adjoining defendant's land, from which sewer rates had been collected for five years (Metropolitan Management Act, 1862, section 53) and charged him with portion of cost.

Held that defendant was not liable for any part, as the road was a "street" as defined by Metropolitan Management Act, 1862, section 112.

Vestry appealed to the House of Lords (Dec. 3, 1886) but judgment of Appeal Court was affirmed, and appeal dismissed with costs (T.L.R., H.L., vol. iii. p. 161).

Bateman v. *Poplar District Board of Works.*

Appeal Court, July 30, 1886. (L.T., vol. iv., N.S., p. 374.)

North (J.) in Chancery Division held that the 9-inch drain was a sewer.

Cotton and Lindley (L.JJ.)—Lopes (L.J.) dissentiente—reversed North's (J.) decision, and declared the drain was not a sewer.

Bateman v. *Poplar District Board of Works.*

Court of Appeal, November 2, 3, 7, 8, 9, 10, 14, 15, December 5, 1887.

If a drain which was originally a private drain is surreptitiously converted into a sewer by reason of another drain being connected to it without knowledge or consent of Board of Works, then Board is not responsible.

Spencer, Turner & Baldero v. *Watson.*

Marylebone County Court, January 20, 1892.

Plaintiffs (tenants) instructed a builder to remedy drains. Vestry then served notice on defendant (owner) to do all the works required, including that done by plaintiffs. Defendant made default and plaintiffs did work. Two-thirds of work done before notice from vestry.

Judge decided that defendant was liable for all work after the notice, but not before.

Neall v. *Vestry of St. Giles, Camberwell.*

Justice Grantham and a Jury, February 9, 1892.

Plaintiff claimed damages against Vestry and from Myring (a contractor) for trespass. This was a case of combined drainage. The drain of No. 24 ran through garden of No. 26, and after joining the drain of No. 26 ran into the land of No. 28, and thence into main sewer. Work done at No. 26 by order of the Vestry caused drain at No. 24 to be exposed (the trespass complained of) and a nuisance caused. The owner of No. 26 would not allow owner of No. 24 to drain through No. 26 without payment. Vestry denied trespass and pleaded that Myring was the trespasser, who had paid 5*l.* into court.

Jury gave verdict for plaintiff for 10*l.* against Vestry and 5*l.* against Myring, with costs.

Home and Colonial Stores v. *Todd.*

Court of Appeal, January 16, 1891. (T.L.R., vol. viii. p. 271.)

Lambeth Vestry gave notice to owner (Todd) to lay a new drain and traps. Owner made default. Vestry did work and recovered from plaintiffs under section 96 of 25 & 26 Vict. c. 102. Plaintiffs then deducted amount from rent; defendant threatened to distrain, and plaintiff sought injunction to prevent. On statement of case—

North (J.) held that owner was liable to refund amount to plaintiff, without considering whether the proper course for plaintiff was to deduct from the rent or to sue. Bowen and Fry (L. JJ.) concurred.

Pilbrow v. *St. Leonard's Vestry, Shoreditch.*

Buildings in Norfolk Place, erected 1882. No consent to combined operation given. No plans submitted.

Magistrate held that the drain was a combined drain.

Pilbrow appealed. Matthews and Charles (JJ.) confirmed decision.

St. Pancras Vestry v. *Moss.*

Magistrate held that Public Health Act, 1875, did not apply to metropolis. Summons dismissed, as Vestry could not prove consent. 3*l.* 3*s.* costs allowed to defendant, and drain held to be a sewer.

Young (*Clapham S. A.*) v. *Fosten.*

Court of Appeal, May 16, 1893. (L.T., Q.B.D., vol. lxix., N.S., p. 147.)

Magistrate dismissed case against builder, who was charged with repairing a drain in an imperfect manner, holding that "owner" was liable.

Court decided that builder engaged by owner to do the work was liable, and remitted case to magistrate.

Jones v. *Banter.*

Before Mr. Justice Collins and a Jury.

Jones sought an injunction against Banter, to compel her to allow water from her property to flow (as before) through her drain. House No. 4 (Jones's) drained through drains on No. 6 (Banter's), but the latter having had the drains altered under notice from the Vestry, they were so laid that drainage from No. 4 could not flow through drains on No. 6. The injunction was granted, with 40*s.* damages and costs; Justice Collins holding that the drain was a sewer and ought to have been repaired by the Vestry.

Dunnet v. *Seaman.*

Clerkenwell County Court.

Plaintiff sued Defendant for 50*l.* owing to the imperfect condition of the drains. Defendant pleaded that under the agreement to let, it was Plaintiff's duty to make drains good.

Judge held that if the drains were wrong at commencement of tenancy, Defendant was liable, and gave verdict for 25*l.* for Plaintiff, and for 11*l.* for rent for Defendant.

CASES UNDER PUBLIC HEALTH ACT, 1875.

Holmes v. *Twickenham Local Board.*

Appeal Court, March 14, 1887. (T.L.R., Q.B.D., vol. iii. p. 477.)

Building owners put down sewer sufficient for property. Local Board constructed new system of sewerage. Reconstructed the sewer, apportioning cost on frontagers.

Magistrates decided in favour of Local Board.

Court of Appeal reversed decision.

Bonella v. *Twickenham Local Board.*

Divisional Court, March 14, 1887. (L.R., Q.B.D., vol. xviii. p. 577.)

Facts similar to above

Held that Local Board could not charge under section 150 of Public Health Act, 1875.

These cases were taken to Court of Appeal, Nov. 10, 1887, and the judgment affirmed. (T.L.R., C.A., vol. iv. p. 51.)

Lyon v. *Greenhow.*

Divisional Court, March 25, 1892. (T.L.R., Q.B.D., vol. viii. p. 457.)

Plaintiff (mortgagee in possession) sued defendant (occupier). Kingston rural sanitary authority served notice on plaintiff to abate nuisance from pumping sewage from a cesspool. Nuisance abated by connection to sewer of rural sanitary authority, who did the work and charged plaintiff 68*l.* 10*s.* Plaintiff paid under protest, and sought to recover from defendant under terms of lease: "Will make, uphold, support, cleanse and repair, and keep in repair all sewers, drains, cesspools, &c., and other easements belonging to the said premises."

Smith (J.) gave judgment for defendant as the terms of lease did not include a new drain.

Meader v. *W. Cowes Local Board.*

Court of Appeal, February 24, June 16, 1892. (L.R., 1892, 3 Ch. p. 18.)

Held that drain receiving branch drains from ten houses and discharging into a cesspool was not a sewer; affirming decision of Chitty (J.). (Diagram No. 5.)

Hornsey Local Board v. *Davis.*

March 8, 1893. (L.R., 1893, 1 Q.B. p. 756.)

Held that the Local Board could and did accept a sewer in a road, though it had no outfall, and could not remake the sewer and charge the frontagers, although an outfall was now provided.

Tottenham Local Board v. *Williamson.*

March 27, 1893. (T.L.B., Q.B.D., vol. ix. p. 372.)

The Local Board sought to recover amount apportioned by surveyor for paving and sewering road. Defendant, who was second mortgagee, was receiving the rents when the cost of the work was "estimated."

Held that the lien commences at the time of "estimation," and not at the time of completion. Hence defendant was liable.

Terrand v. *Hallas Land and Building Co., Limited.*

May 12, 16, 1893. (L.T., C.A., vol. lxix., N.S., p. 8.)

Company made sewer on building estate for purpose of draining it.

Held that this sewer was vested in the local authority, and was not a sewer made "for the profit of the shareholders."

Stretton's Derby Brewery v. *Mayor of Derby.*

November 1, 2, 25, 1893. (L.T., Ch.D., vol. lxix. p. 791.)

Public sewer passed under brewery. Erection of houses on upper side of brewery caused increased flow of sewage through sewer. In heavy rainfalls the brewery was flooded in the cellars. Owners brought action against Corporation for damages.

Held that Corporation was not liable.

Travis v. *Utley.*

Court of Appeal, November 27, December 4, 1893. (L.R., 1894, 1 Q.B. p. 233.)

Drain passing under three houses and discharging sewage from all three into a public sewer, is a sewer under section 4 of Public Health Act. (See *ante.*)

Handsworth Local Board v. *Taylor.*

December 6, 7, 1893. (L.T., Ch.D., vol. lxix., N.S., p. 798.)

A 9-inch pipe was laid in part of a private street to drain seven houses, plans of which were approved, and connected to sewers. This 9-inch pipe became vested in local authority. Other houses were built, and in 1890 local authority called on frontagers to construct new sewer. In default, local authority did work, and sought to recover.

Held that approving plans of houses did not constitute approval of 9-inch drain, and that therefore frontagers were liable.

Minehead Local Board v. *Luttrell.*

February 23, 1894.

Landowner laid sewers for the purpose of draining a town, greater part of which stood on his land, and for which he levied and received a sewer rate from those whose houses were connected with his sewers.

Held that these sewers were " for his own profit " and did not vest in local authority.

Tordom v. *Parsons.*

August 4, 1894. (L.R., 1894, 2 Q.B. p. 780.)

Respondent, among others, connected w.c. to a drain belonging to the local authority, thereby causing a nuisance. The local authority took proceedings against respondent to abate nuisance.

Held that the local authority should provide proper means of effectually draining their district, and justices were right in dismissing the case.

Reg. v. *Tottenham Local Board.*

Button asked for mandamus to compel the Local Board to make a sewer in a particular way; the Local Board refused. The Local Government Board held an enquiry but did not move.

Mandamus refused, and the Appeal Court confirmed the decision of the Divisional Court.

Blything Union Rural Sanitary Authority v. *Blois Saxmundham Police Court.*

Eight or ten houses drained their waste water and soap-suds into a water-course which had been covered over in 1883. The covering was now decayed, and a nuisance arose. Defendant denied his liability. No order to abate was made.

CASES BEFORE MAGISTRATES.

Planet Building Society v. *Turnham.*

January 20, 1892.

Smith (J.) held that defendant was liable for repairs to existing system of drains on property leased to him and containing covenant to repair, but that he was not liable for the cost of improving the system of drainage (thus distinguishing between structural alterations and repairs).

Smith v. *Dundee Commissioners.*

Dundee Small Debt Court, January 20, 1892.

Smith claimed damages for flooding his kitchen, owing, as alleged, to choking of a drain by Duncan, through allowing rubbish to get into a manhole belonging to the Commissioners, and the interference with the drain by the Commissioners in the course of the demolition of a building near.

The sheriff absolved the Commissioners from damage, but fined Duncan 30*s*.

Weed v. *Hatherley.*

Brompton County Court (jury case), January 27, 1892.

Plaintiff sought to recover damages against defendant for imperfect work in draining her house. It was proved that the drains were not water-tight and not laid according to the Vestry's directions.

Judgment for 30*l*. and costs

Bethell v. *Potter.*

Bristol County Court, April 28, 1892.

Plaintiff (owner) sued defendant (tenant) for 10*l.* rent due. Defendant counterclaimed for 21*l.*, for damages in consequence of the defective drainage.

Judge said it was clearly proved that plaintiff had let the house as fit for habitation, and gave verdict for plaintiff for 10*l.* without costs, and for defendant's counterclaim for 21*l.* with costs.

Friern Barnet Local Board v. *Talmondt.*

Highgate Police Court, August 14, 1893.

Defendant was charged with allowing sewage from his premises to flow into a drain or sewer discharging into a water-course within the district of the Friern Barnet Local Board. The house is situate in Clerkenwell detached, pays sewer rates to Clerkenwell, but has no sewers provided and has no right into Friern Barnet sewers.

Order made to disconnect from drain, and pay 5*l.* 5*s.* costs.

Hove Commissioners v. *Messrs. S. A. Self.*

Brighton, October 26, 1894.

Claim for 26*l.* 17*s.* 6*d.* for work done to a drain which drained two houses.

Verdict for Messrs. Self.

DISCUSSION.

Mr. Lewis Angell: The President has called upon me to open the discussion. I was rather intending to reserve my remarks until later in the evening, so as to hear the views of other Members, but as I have some views of my own, perhaps I should assist in promoting discussion by speaking now. This is professedly a meeting of Metropolitan surveyors, and although abutting on the Metropolis, I suppose I must call myself a provincial. Although in some details the law differs between the Metropolis and the country at large, the general principle is the same, and I think we may all discuss the matter on the same lines. Really there is not much to discuss. I think we are all agreed. The points have been very fully brought forward by Mr. Blair and Mr. Godfrey, and although there may be points of difference in practice, on the general question we are agreed. The question is, how is the law to be altered? How shall Parliament be approached? The officers of local authorities are only just waking up to the proportions of this question. Those who were present at the Annual Meeting last year will remember that I endeavoured to raise the point, not for the purpose of discussion, but to impress upon Members the immense importance of this matter. It has grown in some towns to a very serious thing indeed. In my own place, 250 miles of so-called "sewers" have been put under the control of the Corporation which were simply private drains for forty-five years, that is, since the Public Health Act of 1848. The combined back-drainage system—the system advised by the Board of Health, the system which has been propounded in the publications of the Local Government Board and accepted by the Local Authorities and by the public since 1848, until upset by a decision in the courts—and these wretched drains, many of which have been put in surreptitiously, without any proper supervision, are handed over to the local authority to get out scrubbing brushes and other matters put in by the carelessness of tenants. I have had to increase my staff and spend a great deal of money in putting things right which were formerly done by the landlords. How is this to be altered? I do not think we, as officers or an Association, can do anything in the matter, except to work up our various authorities—Town Councils and Local Boards—to take action. I do not think we should approach the Local Government Board ourselves; we may approach privately Members of Parliament, and I have spoken to several; but I am afraid if we approached the Local Government Board as an Association of Officers we might get snubbed, being a matter of policy and of law, a matter for the town clerks and the sanitary authorities and the corporations, and not for ourselves. This I felt so long ago that I moved in my own council at the beginning of last year in the matter; and the town clerk of my Corporation, West Ham, sent a very strong representation to the Local Government Board so long ago as last April, going through the points which have been raised to-night. We got an official answer that it should receive attention, and that was all. On June 30 I brought the matter again before my Council, and the town clerk was again directed to communicate with the Local Government Board, which he did, but we have got nothing more yet. Some Members may have seen the letter of the town clerk, and a memorandum diagram of my own, which was sent round to no less than 1100 Local Boards and Corporations. We received a large number of replies. Some of the local authorities did not appear quite to understand the matter. Some had local Acts by which they could deal with it, but from the most we had replies that they would co-operate with us in obtaining an alteration of the law. What is better, a great many authorities have written to the Local Government Board; so there is no question but the Corporations of the country are now alive to the matter. Then beyond this, the Association of Municipal Corporations, an Association somewhat similar to our own, composed of corporations and the town clerks of the country, has prepared a bill to be introduced into Parliament next session to bring about an alteration of the law. I have received a letter from the secretary of that Association in which he states that he hopes in a few days to invite our town clerk to meet with others when a draft of the bill will be submitted for consideration. Therefore I think, if we make any representation at all, it should be to the Association of Municipal Corporations, and not to attempt any action of our own, except privately through Members of Parliament whom we can influence, also to give our assistance, such as it may be, to the Association of Municipal Corporations. I do not think it is necessary to go through the details which have been discussed in the papers. The present interpretation of the law presses very heavily upon some of us. My district has grown up so quickly that for several years we were building at the rate of 2000 houses a year. The great importance now put upon sanitary work was not then appreciated. I had the greatest difficulty in getting any supervision at all. Houses were run up very fast in a marshy district; there was a good deal of combined drainage, and now with the increase of sanitary interest we have an array of about fourteen inspectors to look up the mischief of the past. Mr. Blair emphasises very properly the laxity of past supervision, which is a reflection on the officers; this army of new inspectors find out what has been done badly in the past, which should have been prevented by the appointment of inspectors in the past when we could not get proper supervision, but we fell back on the idea that if work was badly done, when found out we could serve notice on the owner to put it right. But now almost every private drain has become a sewer. I cannot understand why the London County Council do not act; it is as important to them as to other public bodies of the country. If any Members would like a copy of the West Ham memorandum hereon, which has been sent throughout the country, I shall be very glad to supply them.

Mr. H. Percy Boulnois: May I be permitted to follow Mr. Angell? He spoke as a provincial engineer: I am distinctly representative of that branch of the service; and although this is a Metropolitan meeting this question is of the very greatest importance to every municipal engineer throughout the country. I quite agree with Mr. Angell, however, that the right body to deal with this question is the Association of Municipal Corporations. I think they would have dealt with it before now, but the town clerks of the provinces have said, "Let sleeping dogs lie." In the provinces we have found that the people are not quite so well advised legally as they are in this great Metropolis, and they have lived under the impression that these sewers are drains. As we all of us know, in the provinces we have had very little trouble on this score. But this cloud is looming in the distance; it is pressing upon us, and something must be done. Turning to these excellent papers I shall not criticise them in detail: but on the question of reconstruction of drains, and the neglect to inform the surveyors when reconstruction or alteration of drains has been carried out, I would suggest that the remedy for that is a private Act. We have that at Liverpool, and now nobody may touch his drains to do any alterations or repairs without sending notice to me. With regard to the inspector and the surveyor, Mr. Angell said exactly what I intended to say on this subject. There is no doubt we should divide the two into this category: we may call the inspectors detectors, and the surveyors executors. Let the inspector detect the mischief; then let the surveyor remedy it. Those are the two duties properly defined: let them be carried out.

Mr. WEAVER; How about whitewashing, &c.?

Mr. BOULNOIS: I am speaking only of drainage. With regard to Mr. Godfrey's paper, I thank him for the definition of curtilage, he has carried that out systematically and thoroughly, and his definition has quite cleared up to my mind what has been hitherto a little difficulty. With regard to the combined drainage on Diagram 3, I have been looking at it, but if those drains were deep as in the case of cellars, I fail to see how you could do the drainage. If that diagram is anything like correct it would involve the most troublesome trenches. Perhaps Mr. Godfrey will explain how it can be done; I understand from Mr. Angell it has been done; but I cannot understand how. One other question and I shall have finished. In his paper (see p. 81) Mr. Godfrey mentions the line on which Amendments should follow if we were to approach the Local Government Board. And the first is, "The Public Health Act of 1875 to be so amended as to sanction combined operations." Will he be good enough to explain in detail what he means by that? I am afraid it does not go far enough: if combined operations are to be sanctioned, trouble may follow. This question—the practical question how it is to be decided—should be referred to the Council of our Association who will try and assist the lawyers in coming to a definite conclusion. Before sitting down I should like to thank the authors very heartily. Both the papers are of very great interest to me, and I am sure they are to all of us.

Mr. W. WEAVER: Before I offer any remarks on the papers will you kindly allow me to explain the interjection which I made when Mr. Boulnois was speaking? When Mr. Boulnois was referring to the conflict of jurisdiction between sanitary inspectors and surveyors, I wished to drop a word of warning to surveyors that in undertaking to supervise certain work, they should take care not to have thrust upon them other work which they do not wish to supervise. I have no desire to supervise the trapping of a waste pipe, or cleaning out of a privy, and shall be pleased to leave such work to the sanitary inspectors. Where work has to be done which requires scientific training let those do it who have had the training, and not inspectors who have been taken from the bench, and obtained a Sanitary Institute certificate; but the other things I have spoken of may very well be left to the sanitary inspectors. With regard to the papers, I think the Metropolis must be taken as distinct from the country at large. The drainage principally throughout the country has been done in accordance with certain model bye-laws framed by the Local Government Board, and therefore to get any amendment of the law bearing upon that subject I take it the proper authority would be the Local Government Board. But that Board has nothing to do with the Metropolis. In London the County Council is the absorbing authority which controls this with a multitude of other matters. They have been approached by the local authorities and advised not to proceed with the matter. Perhaps they have not been approached with sufficient power or not properly approached. Perhaps they have not grasped the matter. I think if the question were properly placed before London County Council, and the new Members had the knowledge of Metropolitan matters which they will have in twenty years' time—if they remain Members for so long—they would have taken a different view. It is not a question of the local authorities being called upon to make good a certain number of lineal feet of drain pipe, but it is the incidental outlay which will be required as the outcome of such work. Fifteen years ago my Board took a case into Court and we were made liable for the repair of a large drain: I had to relay the drain. It was not a terrace of small houses such as you might have to deal with in the country, but of large houses, and since the drain had been laid billiard rooms and additions had been built over it, and I had to trench under these buildings. Afterwards, if a wall cracked or a door stuck in that property, it was the Vestry who were liable for what they did ten years previously. Therefore I take it that it would not be the actual work the Vestries would be called upon to do which would cost most, but the incidental work. If local authorities can be saddled with responsibility it is a financial handle with which to turn the key of the money chest. I know in this district of Kensington if this decision of the local authorities is allowed to stand, I have no hesitation in saying that 100,000*l.* will be transferred from the pockets of the local authorities to those of private owners of property. How is the law to be altered? Some of you are aware that the surveyors of London had a district meeting some time ago; we debated the matter at some length, and arrived at a resolution which has been transmitted to the Council for consideration. The view taken at that meeting was this:—that a drain should be considered a drain until it was proved a sewer, in fact, that the onus of proof ought to be on the property owner. That it ought not to be on the local authority to prove that a combined drain is a combined drain and not a sewer, which is beyond the power of the local authority to prove, owing to surreptitious drainage in the past. With regard to a sewer, there is a great deal more form to follow before making a sewer than there is before making a drain. A man cannot well make a surreptitious sewer. With regard to these drains which are called sewers, a man would build a house and drain it without the local authority knowing anything about the drainage; another man would then go and build a house adjoining, tack his drains on to his neighbour's to save expense, and now that is called a sewer. It is adverse to all practical knowledge on the subject, though it may be a dry legal definition of the clause in the Metropolis Management Act which defines a sewer as "a pipe which receives the drainage of more than one house." I take it that if they had the practical experience of a Metropolitan surveyor they would hesitate before they arrived at that decision. There is a deputation going before the County Council next Thursday at 3 o'clock, from each authority in London, to seek such an amendment of the law as will remove this absurdity. There is a preliminary meeting on Monday at half past 2 o'clock, at the Holborn Town Hall, for the purpose of preparing their brief before waiting on the Council on Thursday. I think it would strengthen that deputation if a resolution was arrived at by this meeting, advising that certain steps should be taken. That resolution might be transmitted to-morrow afternoon so as to reach the Holborn Town Hall on Monday afternoon. The resolution might be drafted now, or it might be more properly left to the Council to draft to-morrow. I think it would strengthen the hands of the deputation if it were known at the London County Council that the officers charged with the execution of the work throughout the Metropolis, see that a vast amount of expense will have to be incurred by the local authority which ought to be properly borne by property owners. I am sure that a sentiment of that kind would commend itself to the Council, which is not inclined to give to private owners of property at the expense of the rates. If the London County Council are willing to insert a clause to amend the law in their next General Powers Bill, then the Association of Municipal Corporations might petition Parliament to make the clause applicable to the whole of the country as a certain clause in the Parish Councils Bill was made applicable to London when the Bill was before Parliament.

Mr. Lewis Angell: I have handed in to the chairman a notice of motion in the sense of Mr. Weaver's suggestion.

Mr. Weaver: I should strongly urge that the Holborn Conference have it on Monday so as to strengthen their hands when they go as a deputation to the Council as representing the whole of London on Thursday afternoon.

Mr. J. P. Norrington: As a Metropolitan surveyor and knowing that the London County Council is going to receive a deputation from the various vestries and district boards on Thursday next, in reference to this subject, I should like to endorse what Mr. Weaver has said as to the advisability of sending a resolution from this meeting to the preliminary meeting of delegates which will take place next Monday. I have felt that very great inconvenience and expense will fall upon local authorities in consequence of the unexpected definition of the term sewer, and the judgments it has given rise to; and I can foresee that it will throw not only expense on the authorities, but a vast amount of trouble and responsibility upon the officials. I had recently to reconstruct a so-called sewer under property which a district surveyor, if called in, would probably have condemned as dangerous. The result of having to relay this drain was that I had first to do an immense amount of shoring to keep the buildings up. I fortunately managed to leave the property safe, but I do not know what may result hereafter. The vestry for some time to come is likely to be called upon to compensate the owners should any injury happen to these buildings. A curious case has arisen in my own district, showing how an ordinary "combined drain" may, perhaps, be considered a "sewer." About fifteen years ago a person submitted plans to the vestry, proposing to drain four houses separately into the sewers, and the plans were approved. He afterwards, without informing the local authorities, drained the four houses by one combined operation. The question will now probably arise, and perhaps be fought in the courts, as to whether under these circumstances the vestry is responsible for the maintenance of this combined drain. Then again, several difficulties have occurred in tracing the approval of the plans of certain systems of combined drainage. Many streets in the district have in the course of years had their names changed. And in a recent case I could find no record of the approval of some combined drainage, until I was informed of the change of the name of the street which took place about fourteen years ago. It is also very difficult to identify existing buildings when you consider the ill-drawn so-called plans that were submitted in former years. I wish to tender my thanks to Mr. Blair and Mr. Godfrey for the very excellent way in which the matter has been placed before us, and I again desire to impress upon the Association the necessity of making representations on this subject to the local authorities and the London County Council, which fortunately seems more disposed than it was formerly to consider the matter.

Mr. J. T. Eayrs: I wish to correct Mr. Norrington on one point. I have no recollection of the Council having discussed this question at all, so they have not changed their opinion. The point I rose to explain has reference to a statement in Mr. Godfrey's paper (see p. 79). I want to correct the impression which may exist in the minds of some of the Members as to what is being done at West Bromwich. Some might go away with the idea that we insisted upon a drain for every house connected direct with the sewer in the street. What we are doing at West Bromwich is exactly on the lines adopted by Mr. Walker, of Croydon. Most of the Members will remember that Mr. Walker read a paper in 1891 (vol. xvii. p. 200) on "House Drainage," in which he described a mode by which a number of houses were drained separately to the top of an entry or side passage, and the drain running down that entry or side passage, which received the drainage of two or more houses, was considered a sewer. At the head of that entry or passage was constructed a manhole in which the drainage of each was connected separate. The system is something like that in Diagram 3. It looks absurd as there shown, but it is not quite so bad as that in practice, though it is not to be commended. In West Bromwich we have acknowledged the drain from the public sewer to the manhole at the end of the entry to which all the drains converge, to be a public sewer. In the present state of the law we considered it advisable to insist upon houses being drained separately to a common point where there could be a chamber leading to the sewer in the street. If any of the Members will refer to Mr. Walker's paper they will find the diagrams and particulars of the method he adopts, which may assist them until there has been an alteration of the law. The only difference I make is that the manhole is fixed at the top of the entry in a direct line with the sewer and all houses are drained separately to it.

Mr. T. Walker: I think there are twelve houses on the diagram shown by Mr. Godfrey. I should place an inspection chamber between the first and second, another between the fifth and sixth, and then one behind the ninth and tenth—three inspection chambers for the twelve houses. After draining houses into over 400 inspection chambers, I can assure the Members there is no difficulty, there is no unreasonable expense thrown upon the builders, and the system answers admirably. In reference to the cost of keeping the sewer length and the inspection chamber in repair, it is found to be very trifling indeed. The drains are laid on concrete, and they are tested with water when laid.

Mr. Platt: Where is the syphon?

Mr. Walker: I only put one syphon in on the sewer side of the inspection chamber. I cannot recollect an instance where anything has gone wrong with the whole 400 during the last four years. We are going in for an omnibus Bill in Parliament this year, and are asking for powers that we shall not be responsible for the maintenance of any part of the system. In the meantime we have got very efficient drainage, and it is answering most admirably. With regard to old property with drains out of order, we are pretty busy connecting with the sewers in the same manner. We charge on the rates for laying the drains from the sewer up to and including the inspection chamber. We do not usually put in an inspection chamber unless there are four houses to be drained into it. With rare exceptions the owners are willing to lay new drains into these chambers. I have done a lot of work on these lines. I must say we are not on the same lines as London with long terraces.

Mr. A. D. Greatorex: I should like to allude to my own district to show the extreme importance that something should be done to alter the present law. Three years ago, in my district, which has 2500 houses, there was no system of drainage except cesspools. The Board has spent 55,000*l.* in laying down a system of sewers. We drew up some very strong regulations for the connection of houses. During the last eighteen months 1500 houses have been connected to the new sewers. Two-thirds of these are cottage property, mostly rows of houses. About 10,000*l.* has been spent by the owners of property in this work. This system of house drainage has to some extent followed that adopted by Mr. Walker, of Croydon, but in the case of cottage property combined drainage has been allowed. I prefer to have one straight line at the back of such property to drains passing under houses. In a few years we shall have miles of these drains which will be public sewers. So it is of extreme importance that some alteration should be made in the present state of affairs. I desire to express my thanks to Mr. Blair and Mr. Godfrey for their papers.

Mr. GLOYNE: I have here a draft of the Bill to which Mr. Angell referred. I think, perhaps, for the benefit of the Members I might describe the Bill. It is only a short Bill of two clauses, with three subdivisions. The principal thing in it is a repeal of section 19 of the Public Health Act of 1890, and the substitution in its place of a sub-section of a clause stating that a *private* sewer should mean a sewer which is vested in the local authority, which, not being itself a main sewer, or situated in or under any street, is used for the conveyance of drainage from any premises to a main sewer or a sewer so situated as aforesaid. That also includes widened powers of entry and examination for officers of local authorities. It has been suggested, I think, if this Association were to pass some resolution agreeing with and backing up the Association of Municipal Corporations in regard to this Bill it would help them and us all forward in this work. It is a matter of very great importance throughout the country. I thought the Bill would be of interest to our Members, and I obtained one from our town clerk to bring here.

Mr. C. COOPER: I am afraid we are endeavouring to throw the burden of back drainage on the owners of houses so drained in order to relieve the rates of our respective districts. The question should in the first place be considered from a sanitary point of view as the question as to who is to bear the cost is of secondary importance. There is no doubt that the local authority can keep back drainage in order much better than private persons, especially where a number of persons are interested in one back sewer common to their respective houses. In my own district we have long lengths of back sewers draining the houses of various owners. Suppose notices are served on such owners to relay one of these sewers, and each owner relays so much as passes through his own property, what sort of a sewer would it be when all had finished? It is, in fact, impossible for such owners individually to carry out the work so as to construct an efficient sewer. In Croydon Mr. Walker finds no difficulty in dealing with back drainage. In Wimbledon we have many hundreds of houses built in terraces, and drained by one common sewer at the back which gives very little trouble. The diagram of Florence Road shows the system now in force. The houses are built in blocks of twelve, with a passage between, through which the sewer passes which connects the two branch back sewers with the main sewer in the road. Each branch back sewer takes six houses. Each house drain is disconnected from the back sewer by means of an intercepting chamber. The branch back sewers have each a manhole at their highest end, and one where they join and discharge into the connecting sewer; each branch sewer is ventilated by a ventilating pipe carried up the house near its end.

The President: We have had a very excellent discussion. The question has been thoroughly thrashed out in the best possible manner. I understand, however, there are two visitors present who wish to address the Members, and I will call upon them before asking the authors of the papers to reply to the discussion.

Mr. C. Worrell, Chief Clerk, Works Department, St. Pancras: I have to thank you for permitting me, an outsider, to address you on this question, and I will rely upon the courtesy you always show to visitors for a little indulgence in addressing a body of professional gentlemen. It appears to me that this question has been made very much by the lawyers. The provinces are entitled to the utmost sympathy from the Metropolitan officers because the decision in the Halifax case has been sadly accentuated by the remarks of the judge. The judge says in that case, "No doubt this was a decision which would entail very serious consequences to the local authorities in the Borough of Halifax, but they seemed to have brought this upon themselves. At the time that these plans were submitted every one ought to have known that a pipe which received the drainage of more than one house would be a sewer, and that therefore it would become vested in the authority." The judges in the Poplar Board of Works case took the opposite point of view. There the judges reversed the decision of Mr. Justice North and said it was intended to be a drain and not a sewer, which was exactly opposite to the decision in the Halifax case. The Halifax, Poplar, and the Lowther Arcade may be regarded as the most important cases on this question. We are all agreed as to the remedy, that is by Parliamentary interference. The provincials naturally look to the Local Government Board; we in the Metropolis used to look to our parents the Metropolitan

Board of Works: now we look to what I may call our foster parents, the London County Council. How are we treated when we go there? You are treated not merely with cold indifference but almost with repellant language. Though you are going to have a deputation it is to those who have almost prejudged the case, who have emphatically condemned the application to Parliament for the relief you want. What encouragement is there in appearing before a Board who will naturally follow the advice of their professional advisers? But the case is prejudged by the circulation of their opinions; the solicitor to the Council emphatically condemning the idea of applying to Parliament on the ground that the law would have to be retrospective to be of any advantage, and therefore, that is a reason for not going to Parliament. The Parliamentary agent makes the argument still stronger. He tells them it is almost hopeless to think that they would secure anything from Parliament, for the important reason that the legislation would have to be retrospective. Now lawyers are very fond of precedent, and they like to search for precedents, as they ought to, and here these gentlemen have precedents to hand. In the Metropolis Management Act of 1862, there was a gross injustice upon the owners of property in the law that the cost of flagging gravel footpaths should be charged upon the owners of property: they made that retrospective.

The PRESIDENT: Pardon me, you are departing from the subject.

Mr. WORRELL: I am seeking to show precedents for retrospective legislation. In 1890, Mr. Bolton induced the legislature to repeal that unjust section, and his Act became retrospective—severely retrospective—because it was provided that no such footpaths should be dealt with which had not been laid out before the Act of 1855. I think these points should be pressed upon the London County Council, as they may guide the Main Drainage Committee.

Dr. SYKES, medical officer of St. Pancras, London: When Mr. Meade suggested to me that I should speak I did not wish to take any part in the discussion, I was very much afraid I should be inclined to throw cold water upon some of the remarks made. I hope you will consider me speaking as one of the general public rather than from the professional point of view. From the time these Acts have been passed the pipe that carried the sewage of more than one house has been a sewer; several speakers have assumed that. The gentlemen who spoke from West Bromwich and Croydon evidently knew that the pipe which carried the drainage of more than one premises was a sewer. Therefore, I presume the other gentlemen have known this from the time these Acts were passed.

Mr. J. T. Eayrs: Only within the last few years.

Dr. Sykes: I beg your pardon—there was a decision in 1862, and the London County Council quoted that decision. The London County Council says that it was decided long ago, and was known, and had already been settled in the courts, so there was not the slightest doubt about it. Whether that is a convenient arrangement for administrative matters is one thing, whether it is a just thing is another. It may be very convenient for engineers for administrative purposes to have a convenient arrangement, but then you have the great public to consider as well. If the great public have been building on certain lines I think it would be unjust to make the Act retrospective and punish them for doing what they were entitled to do. There is one point arising out of the case of Travis v. Uttley, which has not been touched upon. Justice Wills said that the whole length of that pipe was a sewer. Now one does not like to differ from a judge, but when you come to consider that the portion which drained the highest house only takes the drainage of one premises, the decision makes it appear that the pipe which takes the drainage of one premises is a sewer as well as the pipe which takes the drainage of more than one. If you get that decision reversed you will remove a great deal of the difficulty, but if you treat the whole of the pipes which carry the drainage of more than one premises as drains you will have a very difficult task indeed, and I do not think the London County Council or Parliament will consent to it. I hope you will not take these remarks in an unpleasant manner, but that the greatest caution will be exercised in asking for any alteration of the law.

Mr. W. N. Blair in replying to the discussion, said: I do not think there is much to say in reply, there have been many interesting observations made, and it has turned out, as I hoped, a valuable discussion. The cases quoted in Mr. Godfrey's paper will be useful for reference. A very important point has been touched upon as to the incidental work which follows the reconstruction of these sewers in private property; undoubtedly it does happen very frequently that the injury to buildings costs a great deal more than the work upon the sewer itself, and I have had several cases where great difficulty has been found in rebutting claims which were made most unreasonably upon the vestry as having caused damage to property by reason of small works carried out underneath or adjoining. Mr. Eayrs mentions the system of drainage into back passages. In Liverpool back passages are the rule. There is generally a back street or passage, from 4 feet to 14 feet in width, in which a sewer is constructed at the cost of the owners, and each house or back yard is drained into that. The owners are required to lay the sewer in accordance with plans submitted to and approved by the Corporation, and if properly made, the maintenance is undertaken by the Corporation. I should be very loth to undertake such a series of complications as illustrated in Diagram 3. With reference to the Bill to be promoted by the Association of Municipal Corporations, that will be a very powerful lever to bring about an amendment in the law. I have had a communication from the Secretary of the Association, asking for information on the subject. I told him I was preparing a short paper to read to this meeting, and should be glad to let him have the paper when it was prepared. I think the influence that the Association of Municipal Corporations will be able to exert will probably be greater than any we can bring to bear from this Association. Referring to what Dr. Sykes has said as to its being well known that whatever took the drainage of more than one premises was a sewer, that was subject to a qualification in other clauses both in the Acts of 1855 and 1862, that property may be drained in combination; no doubt many of the cases we are troubled with now were executed with the idea that such drains were combined drains and not sewers. The fact of there being no record has put the responsibility for their maintenance upon the local authority, and that is recognised by one of the law officers of the Council. The solicitor to the Council says, "The result is no doubt that many drains which ought still to be drains have to be considered as sewers, and treated and repaired as such." It is from such a liability we are justified in seeking relief. I do not say we ought to throw upon property owners the liability for what may reasonably be regarded as sewers. There are many of us who have sewers in our districts of which we have no record, but nevertheless they are sewers.

Mr. R. Godfrey in replying to the discussion, said: Mr. Boulnois has asked the question how we are to deal with a number of drains as in diagram No. 3. That is a terrace of cottages paying about 5*s.* 6*d.* a week rent, and none of the drains would be more than 3 or 4 feet deep. They are all built together; they are laid at one time, and would be laid at one operation. That is what the Metropolis Management Act, 1855, understood by a combined operation. There is one point I would like to call the attention of Members to: the Public Health Act says, "Drain means any drain of and used for the drainage of one building only" or "premises within the same curtilage." I contend that the word "within" is responsible for half of our trouble. It is the wrong preposition to use in that case. The word gives you the idea that curtilage means the *ring fence* or *boundary* of the property. Curtilage is the *area* of ground belonging to the house and the outbuildings thereof. As the Century Dictionary says, "In law, the area of land occupied by a dwelling and its yard and outbuildings, and inclosed or deemed as if inclosed for their better use and enjoyment." If that word "within" had been "upon" we should not have fallen into the same trouble as at Halifax and Lowther Arcade. It depends upon that word curtilage more than anything else. In the case of the Inland Revenue Commissioners against Goodfellow the defendant was summoned for firing a gun upon a field adjoining his garden and in his occupation. He contended that he was within his own curtilage; but the Inland Revenue summoned him and convicted him. On appeal the High Court held he was not within his own curtilage.

Mr. LEWIS ANGELL then formally moved: That a Resolution embodying the views of this meeting be forwarded to the conference of delegates from the Vestries and District Boards of the Metropolis to be held at the Holborn Town Hall on Monday the 22nd. inst., and that a copy of such Resolution be also forwarded to the London County Council and the Association of Municipal Corporations, and that the Council of this Association be requested to formulate such Resolution.

Mr. W. WEAVER seconded, and the proposition was unanimously approved.

The PRESIDENT: There is another matter that has to be dealt with, rather an important one, that is a vote of thanks to the authors of the papers. We have had a very exhaustive discussion—I do not remember any question which has been so completely debated—and we have had the best opinion it was possible to obtain on the subject. Therefore I ask you to accord a very hearty vote of thanks to the authors of the papers.

The vote of thanks was carried with acclamation.

The President then proposed a vote of thanks to the President and Council of the Institution of Civil Engineers for the use of the room, which was heartily accorded.

DISTRICT MEETING AT STOCKPORT.

April 27, 1895.

Held at the Sir Ralph Pendlebury Memorial Hall, Stockport.

A. M. Fowler, President, *in the Chair.*

The Members were received by the Mayor of Stockport (Mr. F. R. Robinson, J.P.). He expressed the great pleasure he had in offering a hearty welcome to an Association which did so much for municipal progress. He trusted the Members in their visit would be both interested and instructed.

The District Secretary then read the minutes of the Chester meeting, which were duly confirmed.

Mr. F. S. Button was unanimously re-elected Honorary District Secretary.

The following papers were then read.

STOCKPORT SEWERAGE SCHEME AND MERSEY MILL BRIDGE.

By ALFRED M. FOWLER, M.Inst.C.E., President.

In laying before the Association the scheme now in course of construction for intercepting and treating the sewage at present discharged into the river from about 30 outlets, the author would first mention that the county borough of Stockport is situated on the rivers Mersey, Goyt, Tame and tributary Etherow, and is partly in the county of Lancashire and partly in Cheshire, containing an area of 2167 acres, with a population of 70,250. The parts covered by streets, buildings and premises may be said to be about 760 acres.

The watershed of which these two rivers (Mersey and Tame) flowing through Stockport form an important area, has a gathering ground of 121,280 acres, and receive the sewage from the towns of Mossley, Ashton-under-Lyne, Stalybridge, Dukinfield, Hollingworth, Hyde, Denton, Bredbury, Yeardsley-cum-Whaley, Glossop, and other small places. The Mersey at Stockport is therefore seriously polluted in its course from the town, not only from Stockport itself, but especially from the valley of the Tame, from Stalybridge and the populated district below it. Formerly, this river was very seriously affected by floods, the water rising to above the soffits of the arch of the old Stockport bridge. This, however, will not again occur, inasmuch as the waterworks undertakings of the Manchester Corporation on the river Etherow impound the waters during floods and relieve the river of inundations, but in time of drought seriously affect the sanitary conditions, inasmuch as the compensation water sent down from the Bottoms reservoir of that Corporation does not reach Stockport until about 11 o'clock in the forenoon, previous to which hour the river bed is almost dry. The recent waterworks of the Oldham Corporation in the upper valley of the Tame have also in a marked degree affected the sanitary condition of the river through Stockport; for not only does the Oldham Corporation abstract the bright spring water from this river, but discharges it after use into another valley, although compensation water is sent down in like manner to the provisions enforced by Parliament with regard to the Manchester waterworks. This state of things brings the sanitary condition of the river before the Corporation with greater force than would otherwise be the case. Stockport, in the scheme devised, has, with regard to the pollution of the districts immediately above them, authorised the new intercepting sewers and works to be designed so as to provide for the collection and disposal of these immediate districts if found desirable or necessary.

In designing the scheme of sewerage, many special conditions had to be provided for. It will be noticed that the town is very undulating in its character, rising rapidly from the river on each side, whilst the river itself may be said to be a sluggish stream. The existing sewers—many of them are very old—are formed of rubble stone and bricks, but these are rapidly being displaced by the modern glazed socketed pipe sewers. These existing sewers converge into main sewers at eighteen different points into the river. All these will be intercepted and connected by the scheme before you. The main sewer has had therefore to be laid along the lower part of the valley, nearly parallel with the river, terminating at land about 1¼ miles below the fringe of the town, and will vary in size from 7 feet diameter to 18 inches, having a total length of about 4½ miles. The securing of land upon which to treat the sewage has been a serious matter for the consideration of the Corporation for some years past, but land was secured about four years ago, consisting of 95 acres, of a character and site which is all that can be desired. This land is at a level which necessitates the pumping of the sewage to a height of some 17 feet. The expense of this being a continual cost, and seriously affecting the revenue account, it has been a matter of concern to mature the scheme, so as to reduce the pumping to a minimum lift, securing also a velocity in the flow of sewage in time of drought of upwards of 2 feet per second to ensure cleansing. The gradients did not offer this provision with the ordinary shaped sewer; it was therefore necessary to devise a design to increase the hydraulic mean depth to a maximum. This has been done by narrowing the middle part of the invert, as shown on the drawings, and the objects thus sought have been attained.

The population extending on both sides of the river, the stream has had to be passed under in four places, and in two places—viz. at Brinksway Bridge and Carrington Bridge—inverted siphons have been obliged to be resorted to; whilst at the other two crossings, near Park Bridge and at Tiviot Dale, special means have had to be adopted to prevent this by flattening the tubes so as to keep the gradients to an inclined plane, at the same time securing the full capacity of the sewer. These arrangements are of special design. From the precipitous nature of the land on each side of the river, great volumes of rain-water are discharged through the existing sewers into the river, which in certain periods, as in thunderstorms, will discharge upwards of 50,000 gallons per minute. This estimate of rain-water is based on the gaugings of sewers under the author's charge at Leeds, Salford and other large towns for many years, and the records of rainfall in other towns where it is found that ¼ inch per hour will fall. Two-thirds of this will flow from the parts covered by streets and buildings, which amounts to about $\frac{1}{6}$ inch per hour, and the designs are formed having regard to these facts. It is impossible to make provision for passing off such storms through the main sewer, as this would dilute the ordinary flow of sewage during the active part of the day above 17 times the dry-weather flow. It is therefore arranged to intercept at such periods the sewage and rain when it is diluted to eight times its bulk, or nine times the normal dry-weather flow. To secure this provision, special designs have been made to pass off the flood water by means of weirs so regulated as to admit this amount through an opening at its approach to the weir into the sewer, and when the flood exceeds this quantity the whole will leap forward into the river.

The main sewer at its invert will be lined with blue bricks, and at the sides with best chequer bricks. Ventilators will be placed about every 100 yards apart, and shafts will be taken up the buildings, well above the apex of the roof and away from any windows or openings. All the brick sewers will be easy of access for inspection from end to end by the special arrangement of footways; side entrances and manholes will be provided. The depth of the sewer below the surface varies from 20 feet to 60 feet, being principally through red sandstone rock. The works constructed up to now (about 1½ miles) have been precarious in their execution, inasmuch as the Cheshire Lines Railway has had to be crossed under within a few feet of the rails and the traffic not interfered with; whilst culverts supplying mills with water have had to be passed through and their supply maintained. The difficulty of keeping the works clear of water has been great, and powerful machinery has had to be resorted to.

OUTFALL WORKS.

The outfall works, as before stated, are about 1¼ miles distant from the town on its western side, where 95 acres of land have been purchased upon which to treat the sewage. About 70 acres of this land is moderately uniform on the surface, the remaining 25 acres being at a higher level of 26 feet. The strata are principally gravel and sand to a depth of upwards of 20 feet. To utilise this land, the sewage will be lifted by means of centrifugal pumps in duplicate to a height of about 17 feet. The sewage on its way through the pumping house will be incorporated with a mixture of cream of lime and sulphate of alumina in such proportions as the density of sewage may necessitate to secure precipitation of the flocculent matter in tanks, into which the sewage will be discharged, and allowed to flow either constantly or intermittently. The tanks will be eight in number, 76 feet long and about 44 feet wide at the top. The tanks are so constructed that the sewage can flow through the whole of them, or one, or any number, so as to have the full benefit, when required, of the whole reservoir space. Each tank will be fitted with cast-iron outlet pipes for passing off the effluent water previous to emptying the tanks of the mud; also pipes for passing off the mud into a mud chamber near the building. These pipes will be laid in a subway, fitted with valves, and the whole under perfect inspection from end to end. The mud will be lifted from this well automatically by means of Shone's ejectors into the press house of the building, where the same can be pressed into hard cake so as to be in a portable form for quick removal. It can be thus sent on to any part of the farm where required. After the sewage has been treated by precipitation, the effluent will be passed over the land by means of one main carrier fitted with sluices to be discharged into branch surface carriers, discharged intermittently into four or five acre plots. The ground will be underdrained, which will carry off the treated sewage into the main sewer again below the point where it has been pumped.

MACHINERY.

To carry out the above arrangement it has been necessary to resort to the best possible known pumping machinery, and Messrs. J. and H. Gwynne's (Hammersmith) combined engines and centrifugal pumps have therefore been adopted, at a cost of 4725*l.* This plant comprises a pair of 27-inch "Invincible" patent direct-acting centrifugal pumping engines of the compound jet condensing type, with cylinders side by side, each able to deliver 13,500 gallons per minute against a maximum head of 19 feet; sluice-valves to be attached to the discharge branches of pumps, cast-iron suction pipes, wrought-iron delivery pipes, with all steam, feed and waste water pipes in engine room. The pumps will be fitted with steam ejectors, self-charging the pumps and pipes. It will be found when these machines are started that the Corporation will have one of the most economical sewage-pumping installations in the United Kingdom. The makers of these pumping engines have built machines of very huge dimensions, compared with which those under consideration may be termed small. The last performance of theirs noticed in a recent number of *Engineering* was the replacing of the ten renowned Cornish pumps at the Haarlem Polder in Holland by a pair of "Invincibles," which on trial have saved over 50 per cent. of fuel alone, besides securing greater economy in working expenses. The author therefore looks forward with much pleasure to obtaining very fine results with the new plant. The engines will be each equal to 60 horse-power. The boilers are made by Mr. Thomas Oldham, of Stockport, and are of the Lancashire type, 30 feet long by 8 feet diameter, with 17 tubes to each boiler, fitted with Green's economiser. These will be of mild steel, all tested to a tensile strain of 25 tons per square inch, with 20 per cent. elongation in a bar of 10 inches, the cost for the two boilers being 680*l.* To carry out the work of precipitation, the first floor of the buildings will be fitted with receptacles for mixing the ingredients for treating the sewage, and the second floor will be fitted with pug mills for grinding lime or other chemicals. The roof will be fitted with a cistern to store water. The buildings are laid out, should any cheaper or better means be found to treat the sewage, so as to be adapted to any process. (It may be here mentioned that there are at least twenty processes which will clarify sewage and produce a bright effluent, but when the digits of cost are added up to a total it is found to be overwhelming in expense when applied to treat the sewage of a large town by precipitation.) The buildings are being constructed principally of brickwork, having in view stability, with a moderate amount of appearance, so as to keep down the cost. There will be mud presses in duplicate, pug mills, hoist from lime store, and other fittings.

The work of construction was actively commenced about twelve months ago, the first being let to Messrs. T. and W. Meadows, of Stockport, for 33,500*l.*, for a portion of the main sewer of upwards of two miles, and about a mile and a half of this is finished. This firm also secured the second contract for the buildings, tanks, lodges and other buildings at 20,360*l.* Other smaller contracts have been entered into for boring the land, travelling cranes, and automatic pumps, penstock, &c., at a cost of about 1000*l.* Tenders for constructing the remaining sewers are now before the Council, and the levelling and underdraining of the outfall land will be let by tender at an early date. It may be added that a scheme as accepted by the Council is on a comprehensive plan, and is under the constant supervision of the committee, who meet fortnightly and inspect the works as they progress. No item of expenditure is incurred except it is brought fully under the cognisance of the committee having charge of the matter, and although the contingencies have been great and the work in some parts precarious, it is believed that the same will be carried out as near the estimate as it is possible to calculate—viz. 95,000*l.*, exclusive of land purchase, and legal and engineering expenses.

Mersey Mill Bridge.

This bridge and approaches have recently been constructed by the Corporation. The work is the development, not only of a great sanitary improvement, but has formed an important improved means of communication between the north and south portions of the borough. On the south side of the river a rather extensive rookery of dilapidated and insanitary property has been removed. The cottages, which were occupied by extreme poor, were at a very low level, which has now been filled up to the extent of 8 feet to form the approach to the bridge on this south side. On the north, or opposite side of the river, the land has been filled up about 20 feet, and reformed to convenient levels to the adjoining streets. To form these approaches and retain the filled-in ground, extensive walls have had to be constructed to retain the earthwork. These walls are of special construction, built in piers 10 feet apart, with lateral arches constructed at the front to prevent the water washing into the recesses, and at the back to resist the earthwork falling between the piers. These piers are no thicker from back to front than would have been required for a continuous wall, and by leaving these 10-feet spaces about one-third of the brickwork has been saved, whilst the stability of the structure has been maintained. The abutments to the bridge itself are built solid in brickwork, with stone quoin dressings.

The bridge is 80 feet span, and 54 feet between the main girders, built on the tubular lattice parallel girder principle. The whole of the structure proper is of mild steel, with planted mouldings of cast iron to cover the top and bottom booms, having planted rosettes at the crossings of the lattice bars. The main girders have lateral diagonal bracing, 3 inches by $\frac{1}{2}$ inch, built to stiffen them. There are eighteen transverse girders laid 5 feet apart, surmounted with a boiler-plate flooring $\frac{3}{8}$ inch thick. These transverse girders are suspended to the under side of the main girders by six steel $1\frac{1}{8}$-inch bolts at each end. These—and, in fact, all the steel—are specified to withstand a tensile strain of not less than 28 tons and not more than 32 tons per square inch, with an elongation of 30 per cent. at least without fracture. Each bolt is calculated to withstand a safe load of seven tons, or one-quarter of the breaking weight, so that the suspension bolts to each transverse girder would carry 84 tons, which is more than possibly can be brought to bear on them, inasmuch as the load on the transverse girder could not be more than 40 tons, which is also one-fourth of the breaking weight. The rivets to the main girders are $\frac{7}{8}$ inch, and 4-inch pitch. It will be seen that the whole weight coming on the bridge is transferred by the above arrangement of suspension bolts through the centre of the main girders, thereby getting the full complement of the strength of the metal. The suspension bolts and nuts have Whitworth threads and are screwed closely home. It will therefore be seen, having regard to the tenacity of the steel, that the whole weight in the case of an extraordinary load can never be brought to bear entirely on part of the bolts only; but by reason of the percentage of elongation secured in the metal, the whole of such load must bear upon the whole of the twelve bolts before any one bolt can have an unequal strain. The carriageway of the bridge is paved with wood, and the footpaths with Lancashire flagging and kerb. The retaining walls and abutments to the bridge have cost 5670*l.*, and the steel and ironwork 4970*l.*, making a total cost of 10,640*l.* All the girders are designed to a depth of one-twelfth of the span. These ponderous main girders—which each weigh 45½ tons, and are 86 feet 8 inches long and 6 feet 11½ inches deep—have been put in their places without the slightest resort to scaffolding in the river. The plan adopted was to place on the end of one main girder a "nose piece," or temporary iron framework, about 50 feet long and 7 feet deep (bolted on to the girder) tapering out to a point. The main girder was weighted at the opposite end. The whole structure was then rolled on iron rails forward over the river, and placed in its permanent position by screw jacks on the bed-plates. The whole work was carried out conveniently, economically and without accident.

The following is a tabulated statement of the principal dimensions and weights:—

Clear span	80 ft.
Width of roadway	34 ft.
Width of each footpath	10 ft.
Total width between main girders	54 ft.
Headway above ordinary water level	27 ft. 6 in.
Depth of main girders at centre	6 ft. 11½ in.
Total length of main girders	86 ft. 8 in.
Cross girders, centre to centre	5 ft.
Total weight of two main girders	89 tons.
Total weight of cross girders	83 tons.
Total weight of floor plates	35½ tons.

MUNICIPAL PROGRESS AT STOCKPORT.

By JOHN ATKINSON, A.M.Inst.C.E., Borough Surveyor.

Historical.

The ancient Borough of Stockport consisted of the township of the same name until 1832, when parts of three adjacent townships were added. The mayor, aldermen and burgesses were constituted a corporate body by the Municipal Corporations Act, 1835.

The Borough was divided into six wards in 1837, and redivided into fourteen wards by C. H. Cresswell, Esq., Commissioner appointed by the Home Secretary on June 23, 1894.

Each ward was subdivided into three polling districts by the Town Council on February 6, 1895.

The town became a county borough in 1888; is situate in the Stockport Poor Law Union, and in the geographical counties of Chester and Lancaster. For administrative purposes, however, it is placed wholly in Cheshire. Formerly consisting of one complete township and parts of three others, it was declared to be one parish or township by order of the Local Government Board, dated October 29, 1894, under the powers of the Parish Councils Act.

The rivers Goyt and Tame effect a junction in the town, thereby forming the Mersey.

Water is supplied by a private company, but the gasworks are the property of the Corporation.

Principal Manufactures.

Cotton spinning, felt hatting, rope-making, bleaching, weaving, calico printing and brewing.

Geology.*

The strata of Stockport and district consist of glacial drift, and vary from practically nothing in depth at many points on both sides of the rivers, to 111 feet on the Cheshire side and 127 feet on the Lancashire side. The solid underlying rocks are the Coal Measures, Permian Sandstone, Permian Marl and Pebble Beds.

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* 'Notes on Glacial Geology of Stockport,' by J. W. Gray, F.G.S.

General Statistics.

Area of borough, 2200 acres.

Rateable value, about 272,000*l.*

Population (estimated), 74,000.

Total rates for all purposes in 1894, 4*s.* 2*d.* in the £.

Total debt (about), 400,000*l.*

The current price of 243,000*l.* (total yet issued) of Stockport Corporation 3 per cent. Redeemable Stock is 104*l.*

Density of population, 33 per acre.

Death rate about 24 per 1000.

Number of persons per house, 4·5.

Number of inhabited houses (1894), 16,269.

Average rateable value per head of population, 3*l.* 13*s.*

Preliminary.

The following description of municipal works is not intended as a complete paper, but only a memorandum or synopsis as to the origin, cost, dimensions and other salient features of some of the many important enterprises carried out in recent years, and to show that the members of the Council and burgesses are fully alive to the advantages derived from wider streets, removal of insanitary property, quicker means of communication, and the provision of parks, recreation grounds, baths, markets, town depôts, well paved and lighted streets, facilities for higher and technical education, efficient sewerage, isolation of cases of infectious disease, cleansing streets, removal of refuse, &c.

Stables at Portwood Cattle Market.

These are the property of the sanitary committee, and were erected in 1891 for the housing of the horses necessary for day and night scavenging, for storage of plant, &c., and generally to serve as a sanitary depôt.

They are built in one block, facing south. In the centre is an engine room containing a "Stockport" 6 horse-power gas engine, corn chamber and office, and a loose box. There is accommodation for thirty horses (with three loose boxes for sick horses), arranged fifteen on each side of the central block, in eight-horse and seven-horse stables respectively. Over the central portion and the two eight-horse stables are hay, straw and corn stores, with hoist, shafting, crushing and chopping machinery. Cart sheds, drying room, dining room and caretaker's house are erected adjoining the river, and in close proximity to the range of stables. In the engine room is a pump of 3-inch ram and 5-inch stroke, for lifting water from the river for washing carts and vans. All internal walls are lined with cream enamel bricks, salt-glazed dado, and coloured bands. The floors of cart-sheds are of concrete, 6 inches thick, having a ½-inch facing of fine granite chippings and cement in equal parts.

The total cost amounted to 5681*l.* 15*s.* 10*d.* Taking the original tender for the buildings only (which was based upon excavating an ordinary depth for footings—the difference between the tender and the amount of the final measurements being due to deeper foundations), adding the value of all fittings and machinery, but excluding paving the yard, salary of clerk of works, and some miscellaneous matters, the cost per cubic foot is as follows:—6*d.* for stables; 4*d.* for cart sheds, dining and drying rooms.

The cost per horse for the entire depôt (30 horses) is approximately 189*l.*

The following statement gives the cost of buildings, fittings, &c.

	£	*s.*	*d.*
Contractor's account for buildings	*4438	19	3
Stable fittings	311	3	11
Hoist, shafting and corn shoots	70	17	0
Gas engine	137	15	0
Gas and water services, meters, lamps	159	2	2
Heating apparatus	30	10	2
Pump, hose pipe and reel	50	15	4
Paving yard	243	11	10
Clerk of works	132	12	0
Miscellaneous items	106	9	2
Total	£5681	15	10

Surveyor's estimate, and amount of loan sanctioned by Local Government Board, February 13, 1891, £5500.

Area of site, 2980 square yards.

Rent of land (paid to Manorial Tolls Committee), 35*l.* per year.

The depôt was erected from the designs and under the supervision of the writer.

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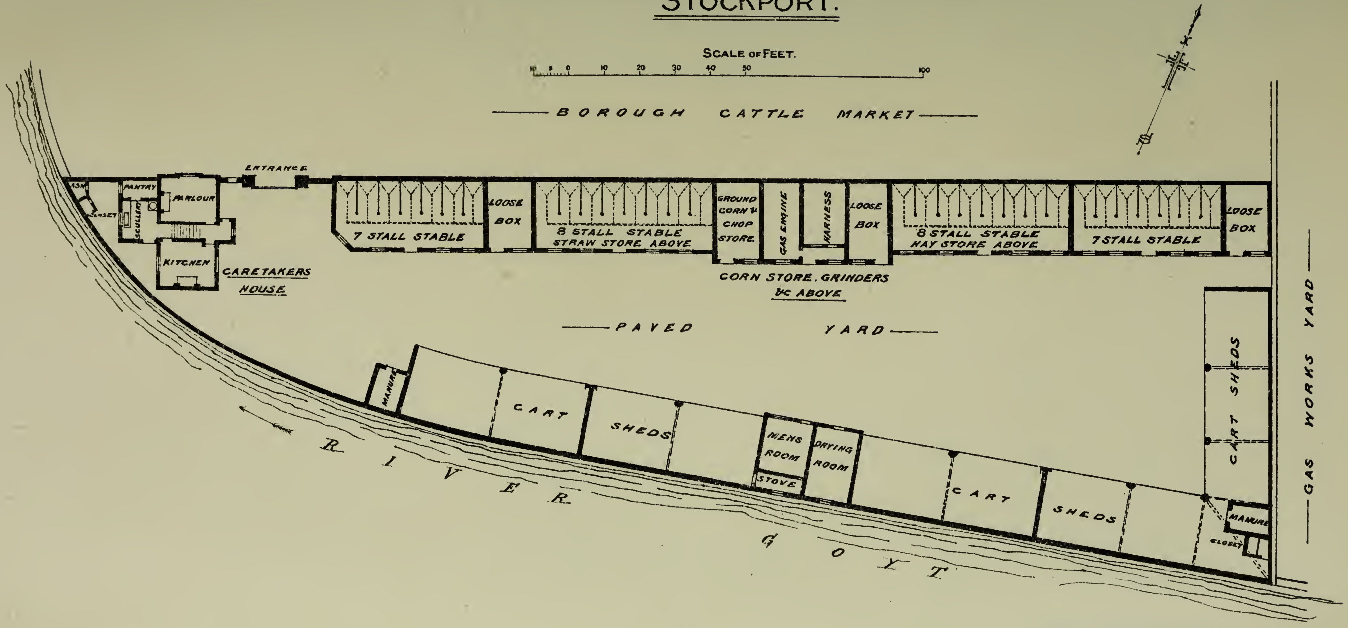
* Original amount of tender, £4349.

STABLES AND SANITARY DEPÔT

STOCKPORT.



JOHN ATKINSON. A.M.I.C.E.
BOROUGH SURVEYOR

LIBRARY
OF THE
UNIVERSITY of ILLINOIS.

BATHS.

A small public swimming bath and washhouse was built about 1857, but in 1884 the present buildings, consisting of plunge, slipper and Turkish baths were erected. The old plunge bath was adopted as part of the scheme, and is utilised as a "penny" boys' swimming bath. As is the case elsewhere, the baths fail to pay. The average loss on the Stockport Institution is about 200*l.* yearly.

Total cost of buildings, about 10,400*l.*

Chief rent, 9*l.* 0*s.* 4*d.* per annum (on 189 square yards).

Area of site, 2471 yards.

Architect, J. C. Prestwich, Esq., Leigh, Lancashire.

Baths opened July 1, 1886.

Slipper baths number 34, namely:—

Men—16 First Class.
„ 12 Second Class.
Women—6 First Class.

Water supplied by Stockport Water Company, price 6*d.* per 1000 gallons.

The Turkish baths comprise three hot rooms, shampooing and cooling rooms, the latter for smokers and non-smokers, with ten separate dressing boxes. The Turkish baths are well patronised.

Annual number of persons using all classes of baths averages 80,000.

PLUNGE BATHS.

Description.	Dimensions.	Quantity of Water contained.
1st Class, Men's	90 ft. long, 30 ft. wide, 6 ft. to 3 ft. 6 in. deep.	About 80,000 galls.
2nd Class, Boys'	60 ft. long, 33 ft. wide, 5 ft. 6 in. to 3 ft. deep.	„ 50,000 „
Ladies'	60 ft. long, 15 ft. wide, 5 ft. to 3 ft. deep.	„ 20,000 „

TECHNICAL SCHOOL.

This was transferred as a free gift to the Corporation on June 7, 1892, the total value of the premises and fittings being 16,874*l.* Area of site, 2300 square yards. Chief rent, 58*l.* 10*s.* 0*d.* per annum. The Corporation have since built an additional wing, viz. large class and examination room, small class room, master's room and museum, and have covered a portion of the yard, the value of the additions being nearly 3000*l.*

George Sedger, Esq., London, was architect; and Messrs. T. and W. Meadows, Stockport, contractors.

There are a large number of day and evening students, the establishment being very successfully conducted by Mr. R. J. Brown, M.Sc., the principal.

The following, copied from the memorial tablet placed in the entrance hall, will explain the means by which the school was erected.

"This technical school was erected in the years 1887–9, through the munificence of Joseph Leigh, J.P., and anonymous friends, and the residuary legatees of the late Sir Joseph Whitworth, Bart., aided by public subscriptions and a grant from the Department of Science and Art. After three years of successful work the school was, on March 7, 1892, transferred as a gift to the County Borough of Stockport, on trust for the purposes of technical instruction, in order that as a municipal institution its usefulness might be extended and perpetuated."

ISOLATION HOSPITALS.

Great Moor Hospital.—Erected 1880. The building cost 4635*l.*, and the site cost 1346*l.* The site contains 3 acres and 1 rood, and is at the junction of Dialstone Lane and Cherry Tree Lane. The building consists of north and south pavilions, and covered corridors at west side, with administrative block in centre.

The old disinfecting stove being useless, it was decided in 1892 to erect a modern one in a suitable building, together with bath rooms, the internal walls having a facing of best white enamelled bricks, with salt-glazed dado. This was done, and the building has been used continuously since June 30, 1893. The cost of the work, including a few pounds for rearrangement of drains, &c., in grounds and old washhouses, was about 800*l.* All infected bedding and clothing, both from the hospital and from patients' residences, is disinfected by steam at a temperature of 260° F., hot air being afterwards drawn into the stove to dry the articles. The apparatus is that known as the "Nottingham Disinfector;" makers, Messrs. Goddard, Massey and Warner.

All convalescents are obliged to have a bath before going home, and persons accompanying infectious cases to the hospital are treated in a similar manner.

Whitehill Hospital.—In 1892 an estate on the north side of the town, 52 acres in extent, with mansion and farm thereon, was purchased for 7500*l.*

The house has since been fitted for hospital purposes, and is intended to be used for the complete isolation of small-pox cases.

PARKS AND RECREATION GROUNDS.

AREAS, &c.

Name.	Acres.	Roods.	Poles.	Date of Opening.
Vernon Park	21	1	38	Sept. 20, 1858
Heaton Norris Recreation Ground ..	16	2	29	May, 1873
Edgeley Park	1	1	36	May 1, 1889
St. Thomas's Recreation Ground	10	1	2½	Oct. 22, 1892
Hollywood Park	12	0	2	June 3, 1893
Total	61	3	27½	

Vernon and Edgeley Parks were presented by Lord Vernon and Messrs. Sykes & Co., respectively; whilst Heaton Norris Recreation Ground was bought for 3000*l.* by public subscription, and then presented to the town.

Vernon and Edgeley Parks are beautifully situated. At the former is a Museum of Natural History, Antiquities, Art and Geology. St. Thomas's Recreation Ground cost 2000*l.*, but has not yet been laid out, being used in its natural condition. Hollywood Park is boldly situated, is laid out, as regards the precipitous portion, in steps and terraces, and the moderately sloping bottom portion of about 4½ acres as a playground. The land cost 8233*l.*, and new works to date about 7000*l.*, the whole being designed by the writer. Gymnasia, shelters, free open-air baths, &c., are proposed to be erected shortly.

Scavenging and Refuse Disposal. Sanitary Farms and Tips.

This work is under the Sanitary Committee, and in charge of the chief sanitary inspector. The refuse is disposed of by burying and by raising the original surface of the land at the following places, viz.:—

Newbridge Lane Depôt, area 4 acres.
Warth Meadow Estate, parts of.
Whitehill Estate, parts of.

At the first named the refuse banks are planted when completed, and the refuse is also filled into the deep holes made by excavating red rock sand for iron-founders, &c. At the two latter the low-lying areas are filled, and the raised land afterwards placed under cultivation.

Markets and Fair Grounds.

The Manorial Tolls of the Borough were purchased by the Corporation in 1847, from Lord Vernon, for the sum of 22,500*l.*

The covered market comprises an area of nearly half an acre.

The present covered market contains inside 84 permanent stalls, made up as follows:—36 butchers, 11 earthenware, 37 drapery, hardware, &c. There are also inside 3 wholesale greengrocers' stalls, and 12 temporary stalls used for flowers and greengrocery.

Outside the covered market there are 3 greengrocery and fruit stalls, 3 cheese and bacon stalls, 2 confectionery stalls and 45 sundry stalls.

In the market hall there are 3 permanent cheese and bacon stalls, 4 rabbit stalls, 1 permanent poultry stall and 1 permanent cutlery stall.

The castle yard adjoining the market is used on Fridays for cattle and pigs, and on Saturdays as a fancy fair.

Fancy fairs are held twice a year on land at Waterloo and Edgeley, both plots being rented by the Corporation. The Cattle Market, Portwood—area 4½ acres—was originally part of a site purchased for gasworks purposes. It has been laid out in a suitable manner, and has recently been refenced on the Great Portwood Street side with massive wall and palisading.

Gasworks.

These are in Heaton Norris, Portwood and Millgate. The gas made at the latter is sent under the river Goyt to the holders at Portwood works. Total area, 12½ acres. Make of gas per day, 2,600,000 cubic feet.

Area of supply (Stockport and out-districts) includes the district within a 4-mile radius from the centre of the town. Length of mains, 112 miles.

Average amount handed over for relief of rates, 8000*l.* per annum.

Very large additions are being made at Portwood, from the designs of Mr. S. Meunier, engineer and manager.

The price per 1000 cubic feet in the Borough is 2*s.* 6*d.*, while outside the Borough 3*s.* is charged,

New Streets and Bridges, Street Widenings and Clearance of Insanitary Property.

Since about 1884 these matters have had unremitting attention, very large sums of money being expended, and still further proposed to be spent.

The loans already taken up for above purposes exceed 73,000*l.*, and sanction for the further borrowing of 43,000*l.* has been applied for.

A large provisional order (prepared by Mr. Fowler) was obtained for these purposes in 1890, and this having lapsed, though several of the works had been carried out, a fresh order was sanctioned in 1894, giving new power in regard to those works not completed, and also for many additional widenings, &c. The plans for the second order were prepared by the writer. The most important new street, which also necessitated 30 feet of filling, is the continuation of Wellington Street from Hillgate to Churchgate.

Almost all the main roads to the centre of the town are being widened. Great Underbank widening has been completed, the property owners rebuilding their shops with good architectural effect. Churchgate widening is about to be commenced, the Corporation acquiring the 240 yards of land required from the rector of Stockport on condition that three shops are erected of sufficient value to replace the rentals destroyed. Plans for same have been prepared by the writer. Two new bridges have been built—Millgate Bridge to cattle market and stables, and Mersey Bridge from Chestergate to Heaton Lane—and Lancashire Bridge widened, all from the designs of Mr. A. M. Fowler, our President; Park Bridge widening—part of the completed scheme of Great Portwood Street improvement—has been carried out from the writer's plans.

In consequence of the various improvements, much insanitary property in the central portions of the town has been demolished.

SEWERAGE.

The town was fairly well sewered—so far as main outlets at right angles to and flowing into the rivers are concerned—during the "Cotton Famine" in 1864, from the plans of the late J. Brierley, Esq., C.E. Much of the work was executed by, and was undertaken to provide employment for, the cotton operatives. Since the above year the Corporation have extended the main lines, and the minor sewers have been put down when new streets have been completed. Being an ancient town, a few obsolete forms of sewers exist, but these are being gradually relaid. Ventilation is by surface gratings, assisted by about forty 6-inch by 4-inch shafts (and a few 6-inch round) up high gables, &c. Several automatic flushing tanks are also provided. Mr. Fowler, the President of this Association, is engaged upon the design and execution of a complete system of main intercepting sewers and sewage purification, estimated to cost 95,000*l.*, in addition to over 16,000*l.* paid for Heathside Farm, Cheadle Heath, the site of the works.

The author is also designing some miles of subsidiary sewers for roads where no sewers exist, to enable property connections to be made more economically than would be the case if owners were compelled to connect to the shafts placed at intervals upon the intercepting sewers. The provision of pipe or brick sewers will also be needed to prevent pollution of watercourses supplying motive power to manufactories, and for considerable portions of the outer parts of the Borough which, being unbuilt upon, have not hitherto needed such provisions.

House drainage is effected mostly from the back, each dwelling built latterly having a separate connection to the main sewer in the 9-feet passage, or back street, constructed in pursuance of the 1890 Public Health Amendment Act. This sewer, serving, perhaps, two blocks of property (rarely exceeding 10–12 houses in length) is trapped before entering the main street, and several ventilating shafts are fixed upon its length from the upper parts of the house drains by the builders, at their own expense.

General.

Fifteen telephonic fire-alarm boxes are placed throughout the town, thus enabling information to be conveyed to headquarters very speedily.

There is a free library, containing 25,000 volumes, with reading room and reference library attached.

About 1½ miles of new streets are laid out, and three to four hundred new houses erected per year. About the same length of streets are paved yearly under the 150th section of the Public Health Act, 1875.

All streets are lighted at ratepayers' expense, the lamps throughout the Borough averaging 60 yards apart. Cost per lamp, 4*l.* 10*s.*; cost of maintenance, 2*l.* 15*s.* 3*d.* per year.

The population has increased by about 1000 per annum since 1881. Complete books, forms and notices are kept in the building department, to record every stage of progress.

Street nomenclature has received drastic attention, 250 duplicate names being altered in 1892.

The Ordnance maps, scales 25 inches and five feet to the mile, have been revised, and the Ordnance Survey officials are about publishing the new sheets.

The Highway Store Yard, St. Petersgate, has been remodelled, paved, drained, &c.

Two companies own and work tramways in the town, whilst Stockport is particularly well served by the London and North-Western, Cheshire Lines, Midland Railway, and other companies, and the Sheffield Company's Canal.

Attention is directed to the stupendous brick arch viaduct, said to be some feet higher than Menai Suspension Bridge, and by which the London and North-Western Railway crosses the valley of the Mersey, about 110 feet above water level.

There are 75 miles of roads, of which over 50 miles are maintained out of the rates. The public highways are well paved with either granite or grit setts, with Lancashire flags, cement, asphalt, or blue tiles on footpaths.

There are only 6 miles of macadam roads, and but an insignificant length of boulder, or "petrified kidney" paving. About 7 or 8 miles of private streets need paving.

Materials now used in paving private streets are fine machine-faced flags in footpaths (or "Best Barns," in important roads), 5-inch edgings, and blue or brown "Lonkey" setts, all from Lancashire quarries. The cost is about 41*s.* per yard of frontage, excluding the value of grouting paving with boiling asphalt and limestone chippings, amounting to about 4*s.* per yard of frontage, and which is defrayed out of the rates.

Over 30 public urinals have been erected by the Council. Those built lately are faced with Accrington "stock" bricks in panels and pilasters, have stone or salt-glazed plinths, heavy stone coping, and are lined with slate slabs (with stall divisions of slate) and salt-glazed bricks. The cost per stall for this class of work is about 12*l.* to 15*l.*

The Corporation are the owners of 272 acres of land in their estates, properties, &c., of a "Purchase" value of about 120,000*l.*, and pay about 760*l.* per annum in chief rents.

The total amount of loans taken up for street improvements, bridges, parks, sanitary, sewage and other purposes since 1890 is over 200,000*l.*, and application has been made for about 43,000*l.* more.

Handsome private houses and public buildings of every class abound throughout the town, whilst many artistic business premises have been erected since the recent schemes of town improvements commenced.

DISCUSSION.

Mr. T. DE COURCY MEADE : I have pleasure in moving a vote of thanks to our President for the excellent paper which he has read. In looking at the drawings on the walls from this distance and listening to the paper without having a print to refer to, it is difficult to follow all the details or to attempt to discuss it. When works are in course of progress it is not always wise to criticise them either adversely or favourably, because questions raised at meetings of this kind are listened to by the public. I think, however, in this instance our President need fear no adverse criticism. It seems to me that the scheme has been carefully thought out in all its details. I am aware that the difficulties in sewering this town are considerable, as I happen to reside in the neighbourhood—indeed not very far from the site of the sewage works—but I have no fear of experiencing any nuisance therefrom. I wish to include in this vote of thanks the name of Mr. G. Atkinson, the borough surveyor, for his paper on the Municipal Works at Stockport. I had an opportunity recently of visiting the fever hospital which he alludes to, and of going through the wards. I must say that the whole arrangements are excellent, and great credit is due to the Borough and also to Dr. Porter, the medical officer, and the other officials responsible for its administration. I was particularly struck with the care bestowed in the prevention of the spread of infectious disease by persons visiting the building: before I was admitted to the wards I was supplied with a waterproof covering, and I found that the wards were well worth a visit.

Mr. J. PATTEN BARBER : I have pleasure in seconding the vote of thanks to yourself, Mr. President, and to the borough surveyor for the excellent papers which we have had. I only regret that we had not your own paper printed, because it contained a large mass of information which it is impossible to criticise from hurried notes taken during the reading of the paper. I do not know, however, that there is much to criticise. I will only venture to ask one or two questions. I should have liked to have had some information, which would be useful to us if it could be added before the paper appears in the Proceedings, as to the depth of gravel at the sewage farm, the formation underlying the gravel, and the nature of the subsoil. Also with regard to the bridge, what travelling load was allowed for in calculating the stresses upon it; with what weight it was tested; and the deflection produced by the testing load; and also the manner in which the girders were bedded upon the abutments. I do not think there is anything to criticise in the surveyor's paper, but in reading of the method of disposal of the refuse I could not help feeling thankful that there was no probability of any of us wanting any water from the neighbourhood of this place. I hope Stockport will never have to seek water from the red sandstone, at any rate in the neighbourhood of these places in which the refuse is deposited.

Mr. Baker: I rise to support the vote of thanks to the authors of the papers, and to ask one or two questions with regard to the construction of the sewage tanks. It appears to me that the cross walls of the tanks as shown in the drawings are of rather heavy construction. Then, do I understand that the pitching of the sides of the slopes is laid on puddle? It seems to me, from my experience, that vertical walls are far preferable and more suitable for settling tanks as the scum will naturally settle among the stones and there will be a great difficulty in keeping them clean. With regard to the main outfall sewer, I should like to know what arrangement was made for the drainage of the subsoil water during the progress of the works; whether there were any drains laid in to sumps at various points. Personally I thank the President most heartily for the opportunity of seeing those most excellent drawings.

The votes of thanks were adopted with acclamation.

The President, in replying to the discussion and the vote of thanks, said: I am sure the older Members of this Association, and with no less force the younger Members of the Association, will know that it is a labour of love to me to be among you at all times, and to give information respecting any works upon which I may be professionally engaged. As I once heard the Dean of Chichester remark, "You always learn a great deal when you are teaching others." If I have said anything to-day which will tend to advance sanitary science, or tend to forward the work of my fellow Members of this Association, I am sure I have done something which is exceedingly gratifying to myself. Of course there are jealousies in all professions, but I am proud to say there are few or no jealousies among our Members, but a desire to assist each other to the utmost of our power. For the success of the work we have in hand here I am greatly indebted to the clerk of the works (Mr. Johnson) who has carried on the work with skill and indomitable pluck. I feel gratified to have this opportunity of publicly thanking him for the manner in which he has done his share of the work. I think you will also say when you see the works that the contractors have done their part admirably. Without a good contractor and a good clerk of the works it would be simply futile for the engineer to attempt to do anything. Unless the work is properly put together the engineer cannot carry out a scheme successfully. In reply to the questions which have been asked, I may say that the gravel at the sewage farm is about 20 feet thick, and about 19 feet above the lower level of the water. With regard to the water in the sewers, we have had to resort to land drains or subsoil drains under the main sewer in order to drain the water down. We could not get on without doing that. I never had an experience of such large quantities of water as we had to deal with here. We have had to leave these drains in; when the work is finished we have filled up the sump hole from which the water is pumped. With regard to the puddle, my practice has always been that if you have a puddle it should be on a good foundation. With regard to the testing of the bridge, there was a deflection of a little over a quarter of an inch in the whole length of the bridge. I must thank you for your attention to my paper, which was, perhaps, rather tedious. I also wish to thank you most sincerely for your attendance here to-day. My only regret is that more Members were not able to attend the meeting.

Mr. Atkinson: I sincerely thank the mover and seconder of the vote of thanks to me, and the Members for so cordially supporting it. The object of the paper was to show the Association that the Stockport Corporation was quite active and alive to all the sanitary requirements of the town, and that they had the disposition to fulfil all the responsibilities of their trust, and if I have succeeded in doing that, and the Association take away that impression, I shall be satisfied.

Mr. J. T. Eayrs: I have very much pleasure in proposing a vote of thanks to the Mayor for his kindness in coming here, no doubt at great personal inconvenience, and for the hearty reception which he has given to the Members at this meeting. I am sure you will all agree unanimously with this resolution, and I can only say that Stockport is not behind other towns which we have visited, in affording every facility to the Members of this Association. Wherever we go we are received with the greatest heartiness and shown everything that is worth seeing.

I couple with the vote of thanks the Trustees of the building in which we are meeting to-day. It is very kind of the Mayor and the Trustees to allow us to meet here in these very handsome and commodious premises; for although it is a private building we have had the privilege of meeting here. I think our thanks are due to the Mayor and the Trustees of the Hall for their kindness.

Mr. E. G. MAWBEY: I have very great pleasure in seconding the vote of thanks so ably proposed to his worship the Mayor of Stockport. As I did not have an opportunity of speaking upon the paper I should like to say that I think the Mayor and Corporation of Stockport are to be highly congratulated upon having secured the services of one of the oldest, ablest and most valued Members of our Association to carry out these works. I have not had an opportunity of going into the merits of the scheme, but I should like to congratulate you upon your good fortune in having to pump the sewage only such a low lift, which is not easy to arrange with a long line of intercepting sewers; also upon the ample provision for dealing with the storm water at the outfall, and the excellent nature of the soil of the sewage farm, as you have got 20 feet of gravel. I will remind the Members that at Leicester we have only about 15 inches of permeable soil, and then clay to an unknown depth.

The vote of thanks having been unanimously accorded,

The MAYOR, in response, said: I beg to thank you most heartily for the vote of thanks you have carried so unanimously. It has been a source of pleasure to me as to you. I think Associations of this character are doing a very valuable work for the benefit of the health of the people of this country. I hope your labours here to-day will not be in vain, but that you will see something that will be instructive. It is said that engineers' estimates are very largely exceeded, and I can only say that the estimates placed upon my services to-day have very largely exceeded their value.

After luncheon the Members drove to the outfall of the Sewerage Works, which are in course of construction, and which are fully described in the paper read by the President, who is the engineer for the scheme, the Steel Lattice Tubular Bridge across the River Mersey, the Technical Schools and the new Stables.

DISTRICT MEETING AT BRIGHTON.

May 4, 1895.

Held at the Royal Pavilion, Brighton.

A. M. Fowler, President, *in the Chair.*

The Mayor (Alderman W. Botting, J. P.) offered the Members a hearty welcome to Brighton, and pointed out that besides the various extensive municipal works that were to be described and visited, there were other places to interest engineers and architects.

The President reported with regret the resignation of Mr. O. C. Robson, as the Honorary Secretary of the Home Counties District.

It was proposed by Mr. T. Walker, seconded by Mr. Mann, that Mr. G. B. Laffan, of Twickenham, be elected as Honorary Secretary of the District. This was carried unanimously.

Mr. Laffan, in accepting the office, briefly thanked the meeting for the honour of electing him.

Mr. C. Jones then proposed a cordial vote of thanks to Mr. Robson for his long and valuable services to the Association.

This was seconded by Mr. Savage and carried. Mr. Robson replied, stating that his ever multiplying duties compelled him to resign, and thanked the Members for the expression of their kind feeling towards him.

The following paper was then read.

BRIGHTON AND ITS MUNICIPAL WORKS.

By FRANCIS J. C. MAY, M. Inst. C.E.,
Borough Engineer and Surveyor.

The author has ascertained that this attractive and popular seaside town has not been visited by the Association until to-day, although the Association has been in existence for twenty-one years. This apparent neglect is due, no doubt, only to the fact that Brighton, being at the southern extremity of the island of Great Britain, is but little known to the majority of our Members who live so much further north, and has consequently been unappreciated by them in the past.

It will therefore be the object of this paper to place before the Members such facts and figures as will make the charms and advantages of the town from an engineer's point of view both interesting and instructive.

The author thinks, also, he will be able to prove that there is quite as great a spirit of progress and enterprise existing in the municipality of Brighton in the south, as is to be found in those of the busiest and most important towns in the midlands and the north; it is hoped that the Members will go away from this meeting with a desire to revisit the town at no distant date, feeling sure that they will find as many new works to interest them, and afford them as much pleasure and profit then as it is hoped they will experience to-day.

History.

Brighthelmston, the ancient name of the town as recorded in the Domesday Book, is probably of Saxon origin, and is derived from the name of a Saxon bishop, St. Brighthelm, who resided here during the Heptarchy. The earliest record of the modern name "Brighton" appears in the Burrell MSS. which were written during the reign of Henry IV. The early history of the town is very vague. It obtained a charter in the year 1313 to hold a weekly market, but it does not appear to have occupied a position of any importance for centuries, beyond that of a successful and thriving fishing village. The author of 'A Tour through Great Britain,' dated 1724, says, "Brighthelmston is a poor fishing town, old built, and on the very edge of the sea. The sea is very unkind to this town, and has by its continued encroachments, so gained upon it, that in a little time more the inhabitants might reasonably expect that it would eat up the whole town, above one hundred houses having been drowned by the water in a few years past; and they are now obliged to get a brief granted them to beg money all over England to raise banks against the water; the expense of which, the brief expressly says, will be 8000*l.*, which, if one were to look on the town, would seem to be more than all the houses are worth."

It was about the year 1736 that visitors of distinction began annually to visit Brighton, the only accommodation being a few indifferent inns, and the principal diversions were hunting, occasional horse-racing and water excursions.

Dr. Richard Russell, a resident medical practitioner, may, in truth, be considered the founder of Brighton's greatness. About the year 1750 he established his fame, and also that of the town, all over the kingdom, by the medical use of sea-water in scrofulous and other glandular complaints.

The erection of lodging-houses soon became a profitable speculation in Brighton, and the late obscure fishing village began to increase in population and celebrity.

In the year 1761 the population was about 2000. In the year 1772 an Act of Parliament was obtained for a daily market. This is evidence of some considerable progress having been made. The ascendency of Brighton over every other marine resort in the kingdom, may be regarded as having been established by the attachment to the town of His Royal Highness the Prince of Wales, afterwards George IV., who in 1782, when he was about twenty years of age, honoured it for the first time with his presence on the occasion of a visit to his uncle the Duke of Cumberland, who then occupied Grove House (since demolished).

The following year the Prince repeated his visit, and bought some property with a view to building himself a marine residence. This residence is known as "The Royal Pavilion." Its erection was commenced in the year 1784, and was completed in the year 1787. The architect was a Mr. Nash, and the building, with its furniture, &c., is said to have cost upwards of a million pounds.

After the Prince had taken up his abode at the Royal Pavilion, distinguished people of all degrees flocked to Brighton, to be near to and enjoy the society of Royalty; and thus the town became the resort of all the beauty and fashion of the age, a position which it still holds, and of which it is justly proud.

In 1794 (just 100 years ago) the population was 5699, the number of houses 1233, the rateable value 3749*l.* (as assessed in 1791), and the number of streets was fifteen. From 1794 to 1821 (twenty-seven years) the population was quadrupled, increasing from 5699 to 24,429; and from this period a very rapid growth has been maintained, the estimated population at the present time being about 119,604.

The Royal Pavilion was afterwards occupied as a marine residence by William IV. and Queen Victoria, until she determined to build Osborne House in the Isle of Wight. The last Royal visit was made in 1844, and soon afterwards the Royal Pavilion became despoiled of its costly furniture and fittings.

In 1850 the Royal Pavilion was purchased by the Town Commissioners from the Crown for the sum of 60,000*l*, and has since then been used for the purposes of municipal hospitality and entertainments, and for public and private balls, meetings, &c.

The suites of rooms within the palace, when furnished for the various high-class balls for which Brighton is noted, present an appearance in themselves quite unique, and by the aid of the splendid decorations usually provided, are made to give a fair representation of the veritable fairy land.

The Royal Chapel has been pulled down, and the Corporation has erected valuable business properties on the site.

"The Dome" was formerly the royal stable-yard, but while maintaining all its principal features, the Corporation has converted it into a magnificent Assembly Hall, capable of seating upwards of 2000 persons. A very excellent and powerful organ has been placed in the building.

The royal riding-school has also been converted to use as a Corn Market, and for holding large meetings. It is capable of seating about 2000 persons.

The alterations to these buildings were carried out during the years 1866–7–8, at a cost of about £7310.

In 1871 a Free Reading Room and Reference Library, Museum, and Picture Gallery were established in the grounds adjoining "the Dome," at a cost of 7402*l.*

In the year 1889 a Free Public Lending Library was added, at a cost of £2350 for books and fittings, from funds raised by public subscription to commemorate the jubilee of the reign of Her Most Gracious Majesty Queen Victoria, and was opened in connection with the older institution.

"The Dormitories," the building provided for the use of the royal domestic servants, is now let by the Corporation for use as a large furniture store and warehouse.

Having given a brief outline of the origin and early history of Brighton, and the causes which have conduced to its present position as a fashionable and popular progressive sea-side health resort, the author will now proceed to give—

Section I.—A description of the climate and geological features of the town, and a review of the improvements executed by the governing body of the town before its incorporation.

Section II.—A description of the works carried out by the Town Council, from the date of the incorporation of the town in 1854 to 1888. (The author's predecessor, Mr. P. C. Lockwood, was Borough Surveyor during the greater part of the period, i.e. from 1858 to 1888).

Section III.—The works carried out by the Town Council from 1889 to 1895, the period during which the author has had the honour of acting as Borough Engineer and Surveyor.

Section I.

From time immemorial until the year 1854, the town was governed by a body of Head-boroughs or Commissioners, of whom the High Constable was the chief, by whose direction all the hereinafter mentioned works were carried out.

The situation of Brighton is in 50° 55′ N. latitude, and about 3′ W. longitude, on the eastern side of a shallow bay of the south coast; the centre of the town is in a valley, sheltered from the piercing north and east winds by the South Downs of Sussex, and facing nearly due west, which renders it a most desirable place of residence during the inclement weather so prevalent in our climate from September to the end of April or even later.

The geological formation in the east, north and north-west parts of the town is wholly chalk, with a thin layer of soil on the top. In the centre the subsoil is marl and shingle, and in the west there are large beds of clay of a very irregular character.

The surface of the land is very undulating, and the town therefore presents a succession of hills and valleys in every direction, the hills rising in some cases to a level of about 640 feet above the sea. This gives rise to the opinion often expressed, that Brighton, in respect to temperature and the sensation of cold, affords a great variety of climate according as the situations are more or less elevated, sheltered or exposed. The author would here remark that when the wind is in the north or east, the Madeira Road, under the East Cliff, offers to the invalid a climate suggestive of the air of the island whence its name is derived.

The sea, with its fishing, boating and bathing facilities, is one of the great attractions of Brighton, but it has also been its greatest foe.

Lying in such a situation as to be open to the fury of the violent south-west and westerly gales, Brighton has from time immemorial suffered seriously from the encroachments of the sea. Although these inroads have been very extensive, it appears that the skill of the engineer to combat them was not enlisted till after the storm in the year 1713, when the first timber groynes were built westward from the Old Steine. Those eastward, as far as Black Rock, are of more modern construction, commencing about the year 1819, when the sea made rapid inroads upon the whole of the cliffs of the Marine Parade. The money required for these sea defences was raised under the Brighton Town Act of 1810, by means of a coal duty of 2*s.* 6*d.* per ton on all coals brought into the town, but these dues ceased on September 13, 1837. After the construction of these groynes, the building of a sea wall was easily accomplished. The first portion formed was that between West Street and Middle Street, and was opened by King George IV. in the year 1821. The fine old sea wall along the Marine Parade, which is built of lime concrete (at that date quite a novelty), the work of Mr. Lambert, was completed in the year 1835, at a cost of upwards of 100,000*l.* The wall, one mile and a quarter in length, is in many places sixty feet high, twenty-three feet thick at its base, and batters on an average four inches to the foot on the face. After this great work was completed, no other work of importance was undertaken till after the year 1858.

SECTION II.

IMPROVEMENTS CARRIED OUT AFTER THE INCORPORATION OF THE BOROUGH, 1854.

The town of Brighton was incorporated by Royal Charter in the year 1854. The municipal governing body now consists of a mayor, 14 aldermen and 42 councillors.

We have learnt from the ancient history of the town that the sea has always been its dire enemy, and it will not therefore be difficult to understand that the new governing body considered it to be a paramount duty to fight it, and to drive it further from their houses by the aid of engineering skill and intelligence. Much has been done in this respect, but more remains to be done, and you will have evidence before you to-day that the present Corporation are as determined as their predecessors have been in the past, to fight the enemy until it shall not only no longer be able to do them harm, but shall be made to give up such an amount of its possessions in the shape of shingle as shall form a protective foreshore to the town.

The subject of "groyning" as a protective measure against the inroads of the sea is as wide as it is important, and allows plenty of room for a great diversity of opinion.

The author thinks, however, it is generally conceded that Mr. Lockwood has studied and thoroughly mastered the subject, so far as it relates to the protection of the foreshore of Brighton. Facts speak for themselves. The system of groyning, adopted by Mr. Lockwood since the year 1858, has resulted in the reclamation of upwards of twenty-three acres of land from the sea, which has enabled the Corporation to increase the width of the carriage-ways and esplanades on "The Front" to their present noble proportions, besides securing the splendid stretch of beach now to be seen.

The esplanade on the King's Road has been widened three times. The Corporation has thus secured to the town a noble sea-front, nearly three miles in length, with a carriage-way on the top of the cliff of an average width of 53 feet, with an esplanade and parade about 40 feet wide; while under the cliff there is an esplanade from the western boundary to the Albion Groyne, opposite the Aquarium, about 20 feet in width, and eastwards therefrom a carriage-way with a footpath 60 feet wide, known as the Madeira Road, extending from the Aquarium to a point opposite

Sussex Square, near which place a junction is formed with the upper road by means of an inclined road.

The widening of the sea-front has been effected by building arches to carry the roadways, and these arches form pleasant retreats or lounges, having a good view of the sea, and are much enjoyed and sought after by both residents and visitors. This is a very novel feature, and well worth a visit, as some of the arches are fitted up in a most luxurious style.

From the year 1860 upwards of 2000*l.* was spent in providing seats for the comfort of the people on "The Front." Shelters from the weather, and rest for the weary and the invalid have been provided in abundance, together with every convenience and sanitary arrangement to promote their cleanliness, health and comfort while taking exercise and enjoying the sea breezes to recuperate their strength of mind and body.

Nearly 4000*l.* has been spent in the formation of paved cab-stands on "the Front" during the same period.

This long list of improvements on "the Front," exclusive of groynes and sea-walls, has cost the total sum of nearly 75,000*l.* (as per table at end); but there has also been an infinite number of minor improvements within the Borough which it is impossible to mention within the scope of this paper, and of which the total would represent a still further large sum. The author has therefore confined his remarks chiefly to the improvements on the sea-front. These grand works are protected from further inroads of the sea by six concrete groynes and fifteen timber groynes, constructed between the years 1862 and 1888 at a total cost of over 75,000*l.*, of which the details will be found among the tables at the end of this paper.

The street improvements are far too numerous and varied to be named separately, but some idea of their magnitude may be realised from the fact that upwards of 30,000*l.* was spent between the years 1860 and 1888 in the most prominent places alone.

The Corporation of Brighton has been fully alive to the importance of the fulfilment of its duty to provide open spaces as the lungs of the Borough. The disused parochial graveyards have been levelled, laid out with walks, planted with trees and provided with seats, by which means they have become useful open spaces, and are greatly appreciated.

"The Level," an ancient open space of more than 10 acres, lying between the London Road and Lewes Road, quite in the centre of the town, was in the year 1877 taken in hand, and by the judicious outlay of about 2000*l.* rendered a most delightful public recreation ground. In the year 1879 the Corporation received from the executors of the late W. E. Davies, Esq., the bequest of the princely sum of 70,000*l.*, to be applied by them at their discretion for the benefit of the town, and with this money "Preston Park" was purchased in 1882, at a cost of 50,000*l.* It contains about 60 acres of land, and has since been laid out for the use and pleasure of all grades of the public in the most attractive manner, at a further cost of about 15,000*l.* There are to be found cricket grounds, tennis lawns, cycle tracks, a "Rotten Row" for equestrians, walks and drives, chalets, and every public and sanitary convenience for the comfort and health of all ages and sections of society. By the munificent gift of the Race Stand Trustees (Aldermen Abbey, Bridgen and Ridley, and Seymour Burrows, Esq.), the fee simple of "the Race Hill," or "Tenantry Down," containing about 105 acres of land, was acquired for the public use (previously to this the public had only the right of walking over the land), on the easternmost boundary of the Borough, and forms the most delightful and healthful resort that can be imagined, being an interesting portion of the noted South Downs. Here are to be found most magnificent and extensive views over land and water, with the health-giving, balmy air of the Downs, and ozone from the sea—altogether a most lovely, quiet retreat, the highest point being 462 feet above the level of the sea.

The Borough sanatorium and disinfecting station, which may be considered as a temporary building (to be superseded soon by one on a larger scale and of a permanent character), was erected in the year 1881, and with additions since, has cost about 10,000*l.* The sanatorium is situated on an eminence of over 300 feet above Ordnance datum, on the north-eastern corner of the Borough boundary. Although the buildings are of a temporary character, from the fact that they were erected in great haste, owing to fears entertained at that date of an epidemic (which fortunately did not occur), yet they are thoroughly well-appointed in their internal arrangements. There is also an efficient staff, and under the able supervision of the energetic Medical Officer of Health (Dr. Newsholme) it is one of the most useful institutions in the Borough.

The drainage system of the Borough may justly be considered one of the most important sections of the sanitary work of the Engineer and Surveyor's Department. In the year 1860 there were 11 miles of sewers in the streets; in 1888 there were about 70 miles. The importance of this question to such a town as

Brighton was from the first thoroughly recognised, and the following eminent engineers were consulted on the subject: Sir Robert Rawlinson, Sir John Hawkshaw, Sir Joseph Bazalgette, Mr. Hawksley, and Messrs. Bright and McLean, in conjunction with Mr. Lockwood. The result of the combined wisdom and experience of these illustrious men has been the adoption of what we claim to be considered as one of the best systems of main sewers. Such old sewers as were found defective were abolished, and replaced by new; those which were sound were ventilated and otherwise adapted to the new system. The cost of the main sewers was about 120,000*l.* Great care was taken in the construction of the new sewers, to ensure the use of the best materials of their several kinds, and the laying of the pipes with sound joints and true gradients, to render them as nearly self-cleansing as possible. This was no slight task, owing to the steep gradients of many of the streets, in some of which it was found necessary to lay the sewers in a series of steps. The sewers have been so arranged in districts or sections for ventilation as to cut off those of the lower from the higher level.

The system, as first constructed, had three outfalls into the sea, one at each boundary of the Borough—east and west—and one about midway between the boundaries, and opposite the Albion Hotel; but in the year 1869 Sir John Hawkshaw designed the great intercepting sewer, which is laid along the whole front from the western boundary of Hove to the outfall at Portobello, a length of 7¼ miles, 3·87 miles distant from the eastern boundary of Brighton. This intercepting sewer is formed in three sections, and it is built of brickwork in cement, as follows: 9918 feet of 5-foot sewer, 700 feet of 6-foot sewer, 27,826 feet of 7-foot sewer. The fall is 1 in 1760, or 3 feet to the mile.

The cost of the intercepting sewer was 104,608*l.*; it was commenced in 1871 and finished in 1874. The main sewers were originally ventilated only by the usual form of air grates in the centre of the streets, but owing to the steep gradients of many parts this system was found very imperfect, so that as far as practicable they have been closed. A system of large open shafts has now been instituted; these shafts are formed of glazed stoneware tubes, two feet in diameter, built into brickwork, and are carried up in every available situation. This plan has been adopted very extensively, and every opportunity that offers of adding to the number of shafts is carefully sought and utilised. The intercepting sewer is almost entirely closed, but is most efficiently ventilated by means of the furnace constructed at Roedean, about 1¼ mile from the eastern boundary of Brighton. This furnace is kept burning continually, and is quite a unique and interesting feature of the sewerage system of Brighton. The cost of construction was 1341*l.* 9*s.* 8*d.*, and the cost of maintenance is 120*l.* per annum. The Members attending this meeting are invited to visit the furnace, and Mr. Lockwood, who is still Surveyor to the Intercepting Sewers Board, will be prepared on the spot to give a more detailed description of its working, and other particulars connected with the intercepting sewers, than can be embraced within the limits of this paper.

As the intercepting sewer receives the whole of the sewage of the sister town of Hove, the expense of its construction and maintenance is shared between the towns of Hove and Brighton in properly adjusted proportions, under the management of a Joint Sewers Board, composed of ten members of the Hove Commissioners and twenty-eight members of the Town Council of Brighton. The average cost of maintenance is about 1400*l.* per annum. A short time ago it was determined to extend the outfall at Portobello. Formerly the sewage was conducted seawards from the intercepting sewer by three 4 feet diameter wrought-iron tubes, a length of 300 feet from the face of the cliff, but they have recently been extended a further distance of 730 feet, or 1030 feet from the face of the cliff. The cost of this recent extension was 8250*l.* Thus the Corporation of Brighton is relieved from all anxiety or trouble on that much vexed question "the disposal of town sewage," but the position has only been obtained by a bold and masterly grappling with the subject, a spirit which seems to have been the guiding star in all their undertakings.

The water supply of Brighton is now entirely in the hands of the Corporation, having been purchased in the year 1872 at a cost of 352,000*l.* There have been important additions made to the scheme since that date, which have cost several thousands of pounds. The author only alludes to this undertaking in passing, as it is dealt with in a separate paper by my colleague, Mr. Johnstone, the Waterworks Engineer.

The Corporation has duly recognised the truth of the old adage, "cleanliness is next to godliness," and its effect upon the community. We have the sea as a bathing place for those who can afford time for the luxury; there are private bathing institutions in the town for all who can afford the comfort of their appointment; but the Corporation has instituted establishments known as "Public Baths" for males and females, situated in the neighbourhoods where they are most convenient for the working classes, who have the privilege of obtaining a bath at the moderate charges of: first class, hot 6*d.*, cold 3*d.*; second class, hot 2*d.*, cold 1*d.*

The North Road Baths were opened in 1871, at a cost of 1834*l.*; enlarged in 1874, at a cost of 4034*l.*, with further additions in 1885, at a cost of 575*l.* The Park Street Baths were opened in 1888, at a cost of 5544*l.*

SECTION III.

DESCRIPTION OF WORKS EXECUTED FROM 1889 TO 1895.

In the year 1889 the Corporation commenced to build a shelter hall on the Madeira Road. This structure consists of a centre hall, where refreshments can be had in the west wing, free lounge, and in the east wing a subscription reading-room; lavatories and other suitable conveniences for either sex are also provided. The shelter hall is free to the public.

From the centre hall a hydraulic lift was constructed to convey persons and bath chairs from the Madeira Road to the Terrace, or to the Upper Esplanade, known as the Marine Parade, and *vice versâ.* It was supplied and fixed by the Hydraulic Engineering Co., Limited, at a cost of 692*l.* It is of the kind known as the Direct-Acting Hydraulic Balance Passenger Lift, designed for a working pressure of 100 lbs. per square inch, and is capable of raising net loads of 1 ton, say 15 persons including the attendant, to a height of 60 feet. The quantity of water used to work the lift is 90 gallons per journey. The fare charged is ½*d.* each way.

At either end of the hall a colonnade has been constructed of ironwork. The roof is flat and asphalted on the top, and thus forms a delightful promenade terrace.

The total length of this structure is 1310 feet.

The work was completed in 1890 at a cost of 14,029*l.*, including the cost of the lift.

The appearance of this part of the sea-front has since been much improved by the formation opposite the shelter hall of some green enclosures or lawns on the beach. These lawns are about 1200 feet in length and 50 feet broad, and are much appreciated.

In the year 1890 a new scheme for heating the Dome by means of a steam boiler and radiators was carried out at a cost of 316*l.*

A foot-bridge was erected over the railway at London Road Station at a cost of 452*l.*

Six covered seats were built on the King's Road Esplanade at a cost of 750*l.* These seats are wholly of teak and polished plate glass. The roofs are covered with copper. The design is very effective, and the accommodation is most thoroughly appreciated.

The old arches on the Lower Esplanade, which were formerly faced with stucco, were in this year refaced with Ruabon red bricks at a cost of 988*l.* This colour added so much to the appearance of these arches that the whole of the old work on the Lower Esplanade has since been renovated in the same way.

As additional laundry accommodation at the temporary Borough sanatorium had now become a necessity, a new laundry of a permanent character was built, and fitted with steam appliances of the latest improvements by Messrs. Manlove, Alliott & Co., of Nottingham, together with a Washington Lyons' Steam Disinfecting Chamber, at a total cost of 2427*l.*

Electric Light.

In the year 1890 the Corporation decided to establish a municipal generating station for the supply of electric light to the public. Mr. James N. Shoolbred, of 13 Victoria Street, Westminster, was engaged temporarily as their electrical engineer. By his advice the Corporation adopted the "low-tension" system, with armoured cables, laid in the ground under the carriage-ways. The first section of the station in North Road was completed during the year 1891, at a cost of 4732*l.* for the buildings only. The station was extended in the year 1893 at a further cost of 2800*l.*, and other extensive additions have already been commenced, including a new chimney shaft, 220 feet high and 13 feet internal dimensions, which together are estimated to cost 14,000*l.*

As the author's colleague, Mr. Arthur Wright, the present Electrical Engineer and manager, has kindly prepared a paper on these works, all further description of this subject is left to him.

Public Parks.

In the year 1890 the "Queen's Park" was purchased by the Race Stand Trustees for the sum of 13,500*l.*, and presented as a free gift to the Corporation, to be preserved and maintained for the use of the public for ever. This park comprises about 16½ acres. The Corporation expended 12,165*l.* in laying it out, the formation of roads and fences, &c. Owing to the natural undulations of the surface, it is one of the prettiest parks to be seen anywhere.

In 1893 Alderman Baker presented to the Corporation a piece of land in Southdown Road, upwards of four acres in extent, to be dedicated to the use of the public for ever as a free recreation ground. The cost to the Corporation for fencing and laying out the ground was about 2000*l.*

Bird Museum.

In the year 1890 the Corporation acquired as a bequest from the late Mr. E. Booth the most valuable and unique collection of British birds contained in his museum at Dyke Road. There is no other museum of its kind to be compared with it. As a place of instruction and recreation the acquisition of this museum is invaluable.

Baths.

The Corporation decided to adopt a system of cottage baths, to be established in different parts of the town among the small class of houses, instead of adding to the existing large establishments: the principle involved being that of taking the baths to the people. Brunswick Place Cottage Baths were first opened in the year 1891. A long lease of an old house was obtained on favourable terms, and it was converted at a cost of 460*l.* The establishment consists of two men's and one women's first-class, for hot and cold water; six men's and one women's second-class; and apartments for the caretaker.

Cobden Road Cottage Baths followed in the year 1893. In this case the Corporation purchased the land for 450*l.*, and erected a new establishment, consisting of ten second-class baths for hot and cold water, six for men and four for women; five first-class baths, three for men and two for women; and suitable apartments for the caretakers. The cost of the building and fittings was 2222*l.*

This system is highly appreciated by the people, and is therefore a successful undertaking.

The new swimming bath occupies an area of 138 feet long and 61 feet wide, the water surface of the bath itself being 120 feet by 35 feet. The depth of the water at the south end is 3 feet 6 inches and the bottom has a gradual incline to the north end, where the depth is 7 feet. The bath holds about 100,000 gallons of water. There are sixty-five dressing boxes, thirty-four on the east and thirty-one on the west side. These boxes are each 4 feet by 3 feet, and are fitted with seat, footboard, shelf, and hooks for trinkets, hat and coat hooks, looking-glass, comb and brush, and button hook. The front of the boxes is protected by a half door at the bottom, and has a curtain for the upper half.

All the necessary conveniences are arranged on the east side of the building, and consist of a superintendent's office and stores, ladies' room, lavatory, gentlemen's room, and a foot and shower bath for the use of persons who may come direct from their work, and therefore need a wash before entering the swimming bath. The platform at the north end of the bath is 10 feet wide, at the south end 6 feet, and on either side in front of the dressing boxes it is 4 feet 6 inches wide. There is a gallery at the north end, and on the east and west sides of the building, together capable of seating upwards of 500 persons. The galleries are approached by convenient staircases near the entrance, so that the spectators may easily be kept distinct from the swimmers. At the north end of the bath are fixed the diving stages and the spring boards, at the south end is fixed the gliding shoot, and on the east side there is a private gallery for the use of the referee on the occasion of swimming and other competitions.

The walls of the building are constructed externally with Crowborough kiln stock bricks, and there has been no attempt whatever to provide any artistic architectural effect, as the building cannot be seen by the public except at the entrance from North Road, and here a neat entrance porch and lobby have been erected in red brickwork. The walls are lined internally with white glazed bricks to a height of 4 feet 6 inches above the gallery floor, with piers of red glazed bricks. A band of blue bricks terminates with glazed bricks, and above this band the walls are finished with white Suffolk bricks, the piers and arches being finished with red bricks. The paving is all mosaic work. The ironwork forming the fencing to the galleries is a special design, the centre panels being formed by the heraldic arms of the Borough. The whole of the joinery work is carried out in very carefully selected pitch pine. The roof is of the lightest possible construction, carried upon ornamental wrought-iron principals, and is well lighted by a lantern running the whole length of the building.

The bath is lighted artificially entirely by incandescent electric lights, principally by means of six ornamental electroliers in a line over the centre of the bath.

The water in the bath is heated by steam on the patented "Rosher" system.

ALLOTMENTS.

These have not been overlooked. In the year 1890 the Corporation hired from the Marquis of Abergavenny, and laid out, ten acres in about ten-rod plots at Kemp Town. In 1892 they also laid out about eleven acres of land, the property of the Corporation, in Hollingdean Road. These plots also are chiefly ten rods super.

CONDEMNED AREAS.

(Housing of the Working Classes Act.)

Two large areas of slums have been dealt with since 1889. Little St. James's Street site, comprising several small streets, courts and alleys, has been cleared, and one new wide street has been made. The land has all been resold and houses of a good class erected thereon.

Cumberland Place site, of a similar character but larger in area, containing 214 houses, is being cleared at the present time, and it is intended to lay out two new wide streets and build houses suitable for the artisan classes.

ABATTOIR.

In 1893 the erection of an abattoir was commenced. The site forms a part of the Corporation land at Hollingdean Yard; it is about three acres in extent and has a railway siding running through it, and there are good roads adjacent which lead to different parts of the town. A complete scheme was devised covering the whole of the ground, and was so arranged that the buildings might be put up in small sections and extended from time to time as might become necessary.

The first section was completed and opened on June 29, 1894. The position and aspect of the buildings have been selected so that they may be the least affected by the rays of the sun, with a view to keeping them as cool as possible.

The buildings are very substantially built in stock brickwork with red brick dressings. The roofs are covered with tiles, as being the material best calculated to keep the buildings cool. They are lighted principally by a glazed section running the whole length of the roofs on the northern side.

The buildings have been carefully planned so as to embrace every facility for carrying on the work of slaughter in the most merciful manner—all the most approved labour-saving appliances have been adopted in the interests of the trade. The comfort of the animals has been carefully observed: convenient feeding lairs are provided for those which are to be kept for a few days; the fasting lairs are near the slaughter-houses, but are so arranged that a living animal may not see one being slaughtered. As soon as the dressing of a carcass has been completed, the meat is removed from the slaughter-house into hanging rooms opposite the slaughter-house, but entirely cut off from it, so that the meat may not be polluted by any of the smells of the slaughter-house. There are no drains within any building. Everything that is practicable has been done to ensure cleanliness. The interior of the slaughter-houses and hanging-rooms is lined with white glazed bricks to a height of seven feet; and the floors are laid with Stuart's Patent Granolithic Pavement, specially prepared to prevent slipperiness. The ventilation is most ample, and the artificial light is electricity.

Suitable offices have been provided for the masters and the workmen.

All the accounts have not yet been paid, but I estimate the cost will be about £8500.

Main Sewers.

It had long been known that owing to the rapid and great increase of the town, the two main valley sewers were becoming inadequate to properly drain the outlying areas in the case of a heavy rainfall. This became painfully apparent on June 28, 1892, the occasion of a sudden and violent thunderstorm, accompanied by a perfect deluge of rain. Basements of houses were filled with sewage, the manholes and street ventilators emitted fountains of sewage and storm water, so it was evident to every one that some additional means of drainage must be provided. The author was instructed to prepare a scheme for the purpose, and submitted plans to the Works Committee on September 1, 1893. They were adopted, and on May 3, 1894, the tender of Messrs. B. Cooke & Co., Contractors, Battersea, for the execution of the work was accepted—the contract sum being 31,752*l.* The work was commenced on May 28, 1894, and comprises as follows:—

Name of Street or Road.	Gradient.	Average Depth of Sewer.	Internal Diameter or Dimensions of Sewers.	Length in Yards.
		Brick	Sewers.	
		ft. in.		
Old Steine	1 in 43	30 0	8 ft. circular	144⅔
Old Steine .. .. .. Pavilion Grounds .. Marlborough Place .. Gloucester Place .. St. George's Place ..	1 „ 131	22 0	8 „	834⅓
			ft. in. ft. in.	
Preston Road	1 „ 134	18 0	7 6 × 5 0	431
Castle Square	1 „ 13	20 0	2 8 × 2 0	13⅓
Church Street	1 „ 20	20 0	3 3 × 2 6	20
North Road	1 „ 11	17 0	3 10 × 3 0	10⅔
Gloucester Street	1 „ 40	16 0	3 3 × 2 6	13⅓
New England Road	1 „ 80	17 0	6 6 × 2 3	10
Beaconsfield Road	1 „ 63	18 0	4 0 × 2 3	11
Argyle Road	1 „ 19	15 0	4 0 × 2 0	11
Ditchling Rise	1 „ 16	15 0	4 0 × 2 0	5⅓
Springfield Road	1 „ 20	15 0	4 0 × 2 0	13⅓
Dyke Road Drive	1 „ 12	15 0	4 0 × 2 0	12
Stanford Avenue	1 „ 13	15 0	4 6 × 2 6	11
		Pipe	Sewers.	
Montpelier Terrace	1 „ 70	16 6	12 ins.	119

8 Man-holes with movable covers complete.
12 Gullies complete.
10 Bell-mouth junctions.
Storm-water Overflow Chamber, Old Steine.
„ „ „ Junction Road.
„ „ „ Marine Parade.

Also, building a concrete groyne, storm water outlet, and an overflow chamber from the intercepting sewer on the beach opposite the Norfolk Hotel.

Ditto opposite the Old Steine.

DESTRUCTOR.

Up to the present time the house refuse has been screened and the useful parts sold to brickmakers, farmers and others, the roughings being carted on to land wherever suitable tips might be found. This practice has, however, for a long time gradually become more expensive and so generally unsatisfactory that the Corporation decided last year to build a destructor.

The author prepared the plans for a building to contain twelve cells or furnaces back to back, and all the necessary appliances.

The Corporation accepted the tender of Messrs. Manlove, Alliott & Co., 5900*l.*, for the furnaces, &c., together with Boulnois and Brodie's Patent Charging Apparatus.

The buildings are now in course of erection. The contract was let to Messrs. Longley & Co., of Crawley, for 8169*l.*

The levelling of the ground cost 1200*l.*, making a total cost of 15,269*l.*

SEA DEFENCES, &c.

In 1893–4, the western end of the King's Road esplanade was improved; forty new arches were built, and all the old work refaced with Ruabon red bricks at a cost of 6218*l.*

The author prepared the plans for further extensive improvements on various parts of the Front. At Black Rock, the eastern boundary, it is proposed to build two new concrete groynes and short length of sea-wall. For this work tenders have already been invited.

It is proposed to extend the Madeira Road (the undercliff road) to the end of the Borough. This work is being done by the Corporation workmen, and has already been begun.

It is intended to extend the existing Colonnade and Terrace westward as far as the old Chain Pier. This work will be submitted to tender in the course of a few weeks.

It is further proposed to build a sea-wall, one new concrete groyne, and other works, from the west side of the West Pier to the western boundary of the Borough. The tenders for this work will also be invited in the course of a few weeks.

The author leaves the description of the construction of these till after they are completed, as they, with some other contemplated works, may be the subjects of interest on the occasion of a future visit.

The following is a list of such other works, in addition to those of the destructor and sea defences:—

Municipal buildings improvement scheme.

Technical schools.

Alterations and extensions of the buildings on the Pavilion Estate, to form new Free Library and Reading Rooms, Museums, and Picture and Art Galleries.

New Sanatorium.

To give some further idea of the magnitude of the work carried on day by day by the Corporation of Brighton in this department, the following particulars may be found interesting:—

STATISTICS FOR THE YEAR 1894.

	£
Highways	12,082
Scavenging	6,229
Watering	4,397
Collection of house refuse	7,753
Pavements..	3,359
	£33,820

The loads of stone used	14,007
„ mud removed	29,268
„ ashes collected	40,315

The weekly average of wages is £555.
The daily number of horses employed, 110.

STATISTICS.

1895. The area of the Municipal Borough is 2620 acres.

POPULATION, LENGTH OF HIGHWAYS, SEWERS, ETC.

Year.	Population.	Highways.	Sewers.	No. of Houses.
		Miles.	Miles.	
1861	77,693	55	11	13,307
1875	99,374	64½	53½	15,776 (1871)
1891	115,873	85¾	72¼	19,543
1895 (estimated)	119,604	88	74½	19,543 (1891)

		£	s.	d.
1894.	The general district assessment is ..	720,165	15	0
„	The debt at the end of the year was ..	345,820	11	5

„ The rates made, viz.:—

	s.	d.
For Municipal and Sanitary Purposes	3	6 in £
For School Board	0	7½ „
For Poor Law	1	5½ „
Total ..	5	7

DRAINAGE.

	£
Public sewage works	120,000
Intercepting sewer	104,608
Roedean furnace ventilating shaft	1,341
Ventilating shaft and flushing chamber at Rottingdean	1,126
Extension of outfall pipes at Portobello	8,250
Extension of public sewers and storm water overflows, 1894–5 (contract price)	31,752
	£267,077

IMPROVEMENTS ON SEA FRONT.

Date.	Situation.	Particulars.	Cost.		
	EAST.		£	s.	d.
1835	Marine Parade	Sea wall	100,000	0	0
1872	Madeira Road	Road formed	1,004	0	0
1880	Marine Parade	New iron fence, with wooden top-rail.	6,360	0	0
1881–2	"	Tar asphalt laid	1,299	0	0
1883	"	Covered seats erected opposite Lewes Crescent and Marine Square.	256	0	0
1889–90	Do.	Covered seats erected opposite Eaton Place and Lower Rock Gardens.	244	0	0
1890	Madeira Road	Terrace, lift, shelter, halls, lavatories, &c.	15,000	0	0
	WEST.				
1864–5	King's Road and Junction Road.	Widened	9,625	12	3
1866–7	King's Road (Grand Hotel to Western Boundary).	Widened, new retaining wall and iron fence.	3,556	0	0
1871	King's Road (adjoining Aquarium).	Arches, sea wall, &c. ..	1,148	0	0
1880	Junction Road	Tar asphalt laid	92	0	0
1881	King's Road (Grand Hotel to Western Boundary).	Do.	1,000	0	0
1882	King's Road (Westn. Boundary to Cannon Place).	Paved cab-stand laid ..	779	0	0
1883	King's Road (West end)	Enclosures, band-stand, lavatories, &c.	5,887	0	0
1883	King's Road (opposite Regency Square and Bedford Square.	Covered seats erected ..	256	0	0
1888	King's Road	Widening, new iron fence with wooden top-rail, new shelter, hall, arches, tar asphalt, &c.	22,982	0	0
1888–9	Lower Esplanade	Tar asphalt laid	1,740	0	0
1889–90	King's Road	Five covered seats erected	610	0	0
1890	"	New urinal, additions to shelter, hall, lavatory, and a new covered shelter opposite Grand Hotel.	988	0	0
1894	"	New arches, &c.	6,218	2	6
1894	"	Electric lighting with arc lamps.	3,466	2	4
	EAST AND WEST.				
1888	King's Road (Cannon Pl. to Albion Hotel). Marine Parade (Aquarium to Bedford Street). Marine Parade (Bedford Street to Boundary).	Continuous cab-stand .. Detached	1,614	0	0
		Total £	184,124	17	1

GROYNES.

Date.	Situation.	Particulars.	Cost.		
			£	s.	d.
1862	Opposite Steine Street ..	New timber groyne 350 ft. long	1,300	0	0
	„ Broad Street ..	Old timber groyne repaired ..	505	13	9
	„ Albion Hotel ..	124 ft. of old timber groyne rebuilt.	578	18	0
1864	„ Old Steine	Old timber groyne lengthened 52 ft.	760	16	9
	„ East Street	Old timber groyne heightened			
	„ Steine Street ..	„ „			
	„ Pool Valley	„ „			
	„ Charlotte Street ..	New timber groyne 250 ft. long	1,099	0	0
	„ Marine Square ..	„ 250 „	1,100	0	0
	„ Paston Place ..	„ 228 „	1,000	0	0
1865	„ East Street	New concrete groyne 235 „	4,630	11	4
	70 yds. West of Eastern Boundary of Parish.	New timber groyne 300 „	1,560	0	0
1866	Opposite Camelford Street	„ 200 „	1,950	0	0
	„ Rock Place	„ 132 „	2,160	0	0
	„ Charlotte Street ..	Old timber groyne heightened and extended.	460	0	0
	70 ft. East of last	Old timber groyne rebuilt ..	613	0	0
1868	Opposite Percival Terrace ..	New timber groyne 281 ft. long	1,858	0	0
	„ Royal Crescent ..	„ 307 „	1,638	0	0
	„ Paston Place ..	Old timber groyne extended 66 ft. at North end.	361	13	6
1869	„ Old Steine	Old timber groyne rebuilt 270 ft. long.	2,130	12	5
1872	„ German Place ..	New timber groyne 260 ft. long	1,935	17	4
1873	„ Camelford Street	Old timber groyne heightened and extended 64 ft.	407	0	0
	„ Percival Terrace ..	Old timber groyne heightened and repaired.	361	5	2
1874	„ Clarendon Terrace	New timber groyne 184 ft. long	1,020	0	0
1875	„ Chichester Terrace	Old timber groyne repaired ..	139	6	8
	„ Duke's Mound ..	„ „ ..	98	0	0
1876	100 yds. West of Eastern Boundary of Parish.	South end of old timber groyne rebuilt for 220 ft.	800	0	0
	Opposite Old Steine	Old timber groyne repaired ..	771	0	0
	65 yds. West of Eastern Boundary of Parish.	„ „ ..	449	10	5
	Opposite Marine Square ..	„ „ ..	77	9	7
	„ Old Steine	New concrete groyne 164 ft. long	1,546	0	0
	„ East Street	Concrete groyne—steps at South end.	36	9	0
1877	„ Paston Place ..	New concrete groyne 550 ft. long	10,475	0	0
	100 yds. West of Eastern Boundary of Parish.	Old timber groyne repaired ..	539	0	0
	Opposite Chichester Terrace	„ „ ..	347	0	0
	„ Marine Square ..	„ „ ..	240	0	0
	„ Percival Terrace ..	„ „ ..	178	0	0
		Carried over £	43,127	3	11

GROYNES—*continued.*

Date.	Situation.	Particulars.	Cost.		
			£	s.	d.
		Brought over ..	43,127	3	11
1878	Opposite West side of Lewes Crescent.	New timber groyne 241 ft. long	1,468	19	0
1879	„ Percival Terrace..	Old timber groyne repaired ..	166	18	4
	100 yds. West of Eastern Boundary of Parish.	„ „ ..	46	9	6
	Opposite Duke's Mound ..	„ „ ..	494	17	5
1881	„ Percival Terrace ..	South end of old timber groyne rebuilt 128 ft.	181	14	9
	100 yds. West of Eastern Boundary of Parish.	Old timber groyne repaired ..	227	0	9
1883	Opposite Percival Terrace and Chesham Place.	„ „ ..	989	12	2
1884–6	Opposite East Street	New concrete groyne	5,692	0	0
	„ Old Steine	„	3,757	13	10
1884–5	„ Bedford Hotel ..	New timber groyne	668	10	0
1885	„ Western Esplanade	Two iron groynes	352	10	0
1886	„ Bedford Hotel ..	Repairs to timber groyne ..	508	3	7
1888	„ Oriental Place, Regency Sq. & Grand Hotel.	New concrete groynes	6,004	10	0
			63,686	3	3
	General repairs not included in the above, new plankings, keys, land ties, &c., spread over the whole of the groynes		15,278	6	10
		£	78,964	10	1

PRESTON PARK.

Date.	Particulars.	Cost.		
		£	s.	d.
1882	Park purchased..	50,000	0	0
	Laying out	5,000	0	0
1883–4	Iron fencing	4,983	0	0
1885	South gateway	610	0	0
	Cricket Ground	2,268	0	0
1887	Dressing rooms, &c., in cricket ground..	594	0	0
1888	Lavatories, club rooms, &c., in park ..	1,226	0	0
	Cart and implement shed	245	0	0
	Tile Building	117	0	0
1890	Cricket ground, dry area to dressing rooms	91	0	9
1891	Cricket ground, urinal	53	11	3
1893–4	„ „ raising cycle track ..	91	1	6
		£65,278	13	6

QUEEN'S PARK.

Date.	Particulars.	Cost. £	s.	d.
1891	Roadways, Sewers, Walling, &c. ..	5,991	12	8
	Iron Fences	2,604	6	4
	Laying Out, including Lake	3,569	17	0
		£12,165	16	0

PUBLIC BATHS.

Date.	Situation.	Particulars.	Cost. £	s.	d.	Total. £	s.	d.
1871	North Road ..	Baths erected ..	1,834	0	0			
1874	Do. ..	Enlarged	4,034	0	0			
1885	Do. ..	Additions	575	0	0			
1891	Do. ..	"	204	0	0			
						6,647	0	0
1888	Park Street ..	Baths erected ..	..			5,544	0	0
1890	Brunswick Place	" " ..	407	0	0			
1891	Do.	Additions	51	0	0	458	0	0
1892	Cobden Road ..	Baths erected ..	..			2,223	0	0
1895	North Road ..	Swimming Bath (contract) ..	..			5,649	0	0
						£20,521	0	0

WATERWORKS.

Date.	Situation.	Particulars.	Cost. £	s.	d.
1872	Waterworks	Undertaking purchased from the Company at a cost of	352,000	0	0

Subsequent additions have raised the Capital Account to a sum of nearly £540,000.

ELECTRICITY CAPITAL ACCOUNT.

Loan.	£
1891	32,500
1892	13,000
1893	32,001
1894	75,031
	£152,532

ROYAL PAVILION IMPROVEMENTS.

Date.	Situation.	Particulars.	Cost.		
			£	s.	d.
1850	Royal Pavilion	Purchased by Corporation	60,000	0	0
1866–7	Dome	Converted into an assembly room	6,300	0	0
1868	Do.	Orchestra altered	442	0	0
	Corn Exchange	New entrance and floor	568	0	0
1871	Free Library, Museum, and Picture Gallery	Erected	7,402	0	0
1883	Pavilion	Electric lighting	2,705	0	0
1884	Dome, Free Library, &c.	Do.	2,133	0	0
	Pavilion grounds	Tar asphalt paths	160	0	0
	North drawing room	Decorated, &c.	613	0	0
1887	Grounds at New Road and Old Steine	New gateways	64	0	0
	Dome	Backs to seats	97	0	0
1889	Do.	Seats to balcony	115	0	0
1890	Do.	Heating	590	0	0
„	Pavilion	Electric lighting	682	0	0
			£81,871	0	0

PUBLIC WORKS.

Cost of works executed under the superintendence of Mr. Philip C. Lockwood, C.E., the Borough Engineer and Surveyor from 1859 to 1888.

Year.	Cost.	Year.	Cost.	Year.	Cost.
	£		£		£
1859	24,375	1870	61,407	1881	64,661
1860	24,619	1871	65,523	1882	73,439
1861	36,411	1872	63,619	1883	76,580
1862	27,573	1873	42,305	1884	92,742
1863	25,440	1874	46,437	1885	70,047
1864	34,176	1875	55,836	1886	68,324
1865	52,926	1876	46,546	1887	78,537
1866	42,665	1877	57,811	1888	71,737
1867	65,442	1878	53,334		
1868	63,631	1879	57,537		£1,675,580
1869	73,696	1880	58,222		

Cost of works executed under the superintendence of Mr. Francis J. C. May, M. Inst. C.E., the Borough Engineer and Surveyor from 1889 to 1894.

Year.		Cost.
1889		£76,657
1890		73,781
1891		87,035
1892		80,930
1893		93,659
1894	(Estimated)	97,388
		£509,450

The PRESIDENT: Gentlemen, I am sure it is very interesting to hear so complete a paper as we have had. More than that, Mr. May's paper gives information to the general public which must be most valuable to a town like Brighton. I notice that 135,000*l.* has been expended in public parks. It must add considerably to the health and prosperity of the town to have such large open spaces for the enjoyment and recreation of the residents and visitors. It seems to me that Mr. May's paper is so complete that there is nothing for us to discuss.

Mr. LEWIS ANGELL: I have very much pleasure in proposing a vote of thanks to Mr. May for his very interesting paper, which contains a great deal of information, but which I hardly think we can now discuss; we may, however, take it for granted that all the works that have been carried out by Mr. May, and his predecessor Mr. Lockwood, have been most admirably done and well suited for their purpose. I have had the pleasure of knowing both Mr. May and Mr. Lockwood for a great many years, and I think the people of Brighton are to be congratulated upon having had such able and efficient officers to direct their works.

POINTS OF INTEREST IN THE DEVELOPMENT OF ELECTRICITY SUPPLY AT BRIGHTON.

By ARTHUR WRIGHT, Electrical Engineer and Manager of the Corporation Electricity Works.

Perhaps the title the author has chosen may, at first sight, appear to assume too much, but he trusts he will be able to interest the majority of the Members by acquainting them with certain facts connected with the gradual development of electricity supply in Brighton, especially when he states that, as far as he has been able to determine, Brighton was the first town in England—

1. To possess a central station erected for the express purpose of supplying the general public with electricity.
2. In which the inhabitants had the opportunity of paying for the electricity they actually consumed.
3. To have the advantage, or the reverse, of having had electricity supplied by more than four distinct systems of electric distribution during the last ten years.
4. To have been the first town to adopt a differential system of charging for the electricity consumed, based on the actual cost of supplying it to each individual customer.
5. In which electricity has been supplied from one central station, both by the continuous and alternating systems of distribution simultaneously.

The author proposes to briefly relate the principal facts in connection with the first three of the above statements, and to deal more fully with Nos. 4 and 5, as these two last features of the Brighton supply system will probably have the most interest for the Members.

The chief points in connection with the history of the development of the electricity supply in Brighton are the following:—

In 1881 the Brighton Corporation instituted some arc lighting experiments on the Marine Parade; the cost, however, of running the machinery made the magnificent illumination then obtained far too great a luxury for it to be continued.

At the end of the same year, Messrs. Hammond & Co. decided to give the inhabitants of Brighton an opportunity of trying the electric light on their own premises, and for this purpose the author was instructed to erect a small plant and to run the necessary overhead wires. As far as he can learn, this was the first attempt in England to offer the general public an opportunity of having the electric light without having to incur the expense and nuisance involved in putting down generating plant on their own premises. The machinery was placed in Messrs. Reed & Sons' foundry yard in North Road, and overhead wires were run from this point to the principal business thoroughfares.

The supply was started early in February 1882, and since that time the inhabitants of Brighton have always had an opportunity of using electricity and becoming acquainted with its many advantages. It is partly to this long acquaintance with the electric light, among other things, that the recent rapid extension of its use in Brighton is probably due.

For the first sixteen months after the station was started, only arc lamps were supplied, and these were charged for at a fixed rental per month until April 1883, when it was recognised that it would greatly add to the economic working of the supply station to charge for the lamps in proportion to the length of time they were burnt, and in that month was started the system of charging the consumers on a sliding scale system, based on the use they made of the generating plant. As there were no meters in existence then, capable of measuring the current, the plan was adopted of determining the consumption by means of the number of carbons burnt. Reference will be made later to the exact terms of the sliding scale adopted.

In June 1883 incandescent lamps began to be supplied from the same high-tension mains as the arc lamps. The system of supplying them is now generally known as the multiple-series system. These lamps were charged for at a fixed rental until April 1884, when electrolytic meters were devised to actually measure the consumption of electricity by these incandescent lamps. The current consumed in them, as measured by the meters, was charged for on a similar differential basis.

In 1885 the Brighton business of the Hammond Company was turned into a separate joint stock company, and began paying regular dividends in 1886.

The business gradually grew, notwithstanding the high rate, of charge adopted, equivalent in most instances to about 1*s.* 4*d.* per Board of Trade unit.

In 1888 the high tension continuous-current system was replaced throughout the town by the high-tension alternating transformer system. The change over was effected by means of installing storage battery stations, and charging these by the high-tension continuous current. The greater simplicity of the transformer system gave another great impetus to the business, and when the author resigned his position as engineer to the company in 1889, the capital amounted to about 12,000*l.*, and the annual sale of electricity was at the rate of 120,000 units. After that date the business went on increasing to the extent of selling 140,000 units per annum until the year 1891, when in September the Corporation Electricity Works started supplying electricity on the two-wire low-tension system.

When, early in 1893, the result of the Corporation's first year's working was to show that with even on the admittedly inefficient two-wire system, electricity could be supplied from a well-organised station to yield a small profit at 7*d.* per unit, the ultimate extinction of the old company became inevitable, and negotiations were soon commenced for the purchase of the goodwill of the Company by the Corporation; the result being in the following year the company's customers were transferred to the Corporation's mains.

In 1893 the Corporation, recognising that the two-wire system could never be capable of supplying economically the whole of the Borough from their one station, and the greater efficiency of the three-wire system, converted their entire system to the latter form. In the same year they carried out the electric lighting of the King's Road, which work constituted, the author is informed, the first piece of street lighting by means of arc lamps run from the ordinary low-tension distributing mains.

In 1894 the Corporation extended the distributing mains in all directions of the Borough, and put down a high-tension alternating plant for supplying the purely residential districts in the north of the town.

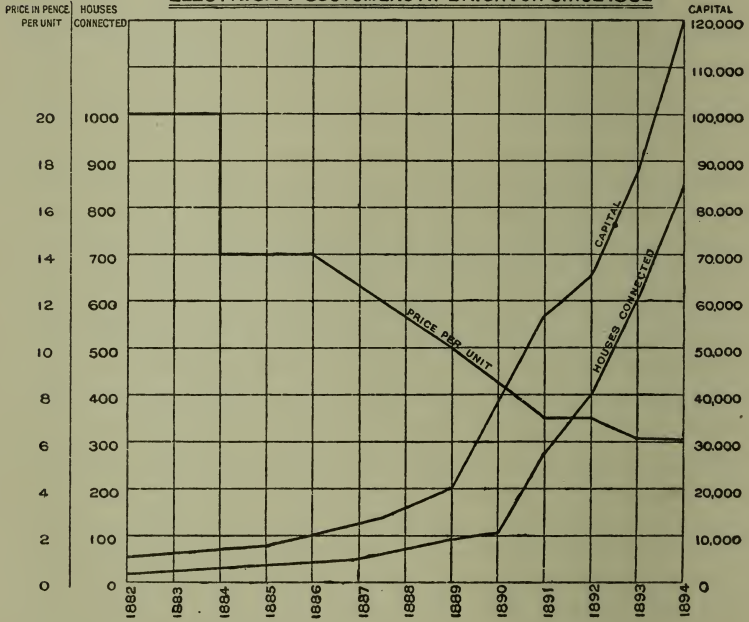
It is in these districts that the unique system has been developed of supplying electricity at light loads by the continuous current, and at heavy loads through the medium of high-tension alternating feeders. Something will be said about this special feature presently.

The following two tables, which are based on the latest published results of most of the central electricity supply stations in the

United Kingdom, prove that in 1894 the actual cost, exclusive of redemption and interest, of supplying electricity from the Brighton Corporation's station, was less than from any other central station in Great Britain, and that the sale of electricity per inhabitant, taking all the towns having more than 50,000 inhabitants, was greatest in Brighton.

When it is recognised that at the end of this year the capital sunk in the Corporation Electricity Works will probably reach 160,000*l.*, that nearly a million units will be sold during the year, that most of the principal streets will be electrically lighted, and that the annual consumption of electricity per inhabitant will in all probability reach the high figure of 8 units, the Members will see how rapidly the electricity undertaking is developing, and this will also be borne out by a study of the diagram "A," which shows how the number of electricity consumers in Brighton has increased since 1882, how the average price charged has diminished, and the gradual increase of the capital involved.

DIAGRAM A SHEWING THE NUMBER OF ELECTRICITY CUSTOMERS AT BRIGHTON SINCE 1882



ACTUAL COST IN PENCE PER UNIT, EXCLUSIVE OF REDEMPTION AND INTEREST FOR THE SUPPLY OF ELECTRICITY FROM THE VARIOUS SUPPLY STATIONS.

Brighton	2·3
Liverpool	2·46
Strand and Charing Cross Company	2·58
Bradford	2·57
Newcastle	2·6
Westminster Electric Supply Company	2·69
Hull	2·86
Kensington	2·86
St. James's and Pall Mall	2·94
Manchester	3
Leeds	3·11
Birmingham	3·54
City of London	3·72

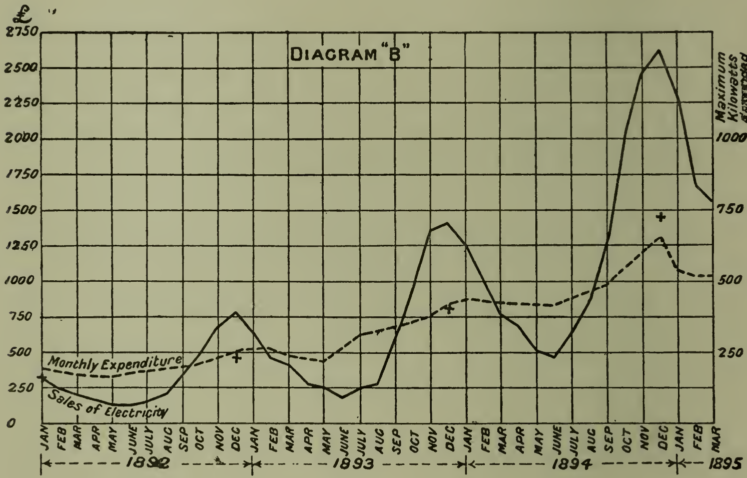
If the Members will extend their indulgence a little longer, the author proposes to go somewhat fully into the two most distinctive features of the Brighton Corporation electricity supply, viz. the method of charging for electricity consumed, and the system of distributing it in the residential scattered districts.

ANNUAL SALE OF ELECTRICITY PER INHABITANT IN THE TOWNS OF OVER 50,000 INHABITANTS OF THE UNITED KINGDOM.

Brighton	4·93 units sold per inhabitant.
Newcastle and its districts	4·12 ,, ,,
Bradford	2·22 ,, ,,
Preston	2 ,, ,,
Liverpool	1·96 ,, ,,
Dublin	1·41 ,, ,,
Bristol	1·32 ,, ,,
Glasgow	1·25 ,, ,,
Manchester	·87 ,, ,,
Birmingham	·81 ,, ,,
Hull	·8 ,, ,,
Leeds	·75 ,, ,,
Sheffield	·55 ,, ,,

It does not seem to be sufficiently well recognised among engineers, that the cost to electricity supply stations of continuing to produce electricity after everything has been put in a state of readiness to do so, constitutes an extremely small proportion of the total expenditure. In order to make this truth more clear to the Members the author is enabled to state, from the experience of the last three and a half years' working of the Brighton Corporation station, that the cost of having to be ready to supply electricity in Brighton in 1895 will probably amount to 80 per cent. of the total annual expenditure; the diagram "B" will show clearly how very slightly the total monthly cost of running the Brighton station since January 1892 to the present time varies, compared to the variation in the corresponding sales of electricity.

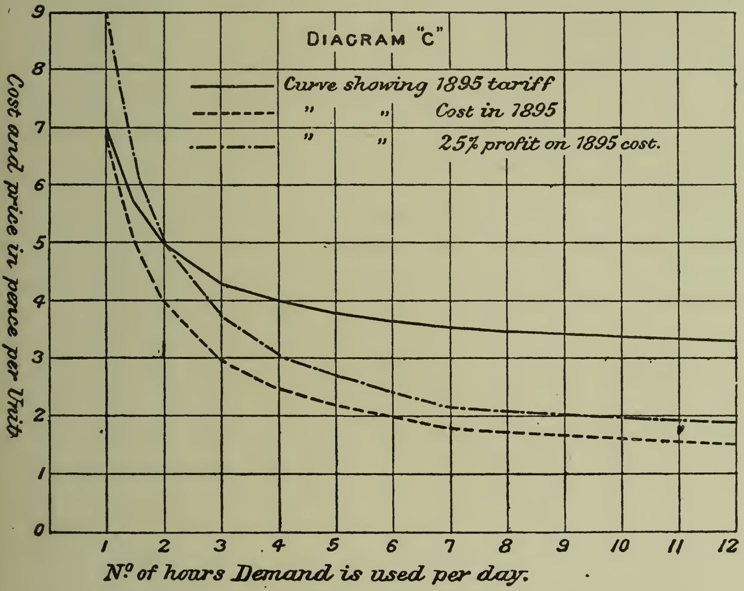
The dotted line shows how the total monthly expenditure has varied during the different years, and the solid line the variation during these years of the monthly sales of electricity, the latter being taken for purposes of comparison at 6*d.* per unit. From this diagram it can be shown that the monthly costs only vary on the average about a quarter as much as the monthly sales do. Another point may be noticed in diagram "B." The crosses indicate the points representing the maximum call on the plant in the different years. One conclusion to be drawn from these curves is that the total monthly expenditure depends much more on the maximum rate at which the generating plant has to supply electricity during any year, than on the actual amount of electricity that has been supplied.



This fact the author recognised in April 1883, when, before meters were devised, he charged the consumers supplied by the old Hammond Company 6*s.* 0*d.* per arc lamp per week, and 1*s.* 6*d.* per carbon used; and after meters had been devised for the incandescent service, the charge was made at the rate of 1*d.* per lamp hour if the lamps were not used three hours per day, and ½*d.* otherwise.

The present method of charging for electricity consumed, adopted by the Brighton Corporation, is an improvement on the above system, but still based on the same principles.

In 1895 the charge for electricity consumed by any one in Brighton is reduced to 3*d.* per unit as soon as the proper proportion of cost of having to be ready to supply that individual has been paid for by the revenue derived from his previous consumption in the same half year, being charged at 7*d.* per unit. This, in the year 1895, happens to be after the use of his greatest demand for one hour per day on the average. By means of this equitable tariff the Corporation are enabled to offer consumers who use their demand regularly four hours a day, electricity at 4*d.* per unit, although coal costs the Corporation over 20*s.* a ton. All electricity consumed in Brighton, whether it be by private individuals or by the Corporation for street lighting and other purposes, is charged on this basis.



The Members will note from diagram "C" and its accompanying table, how rapidly the cost of supplying electricity diminishes in Brighton according to the length of time the demand is used per day, and they will probably agree with the author in thinking that for street lighting (the demand being used in this case on the average nearly eleven hours per day, under which circumstances electricity can be supplied at 2*d.* per unit with a fair margin of profit), the time cannot be far distant when every street in the neighbourhood of the distributing mains will be electrically lighted, for there is no other suitable form of artificial illumination which can compete with electricity at this price.

From the repeated consideration of what items make up the total cost of supplying electricity, and recognising how small, in stations of about the size of the present Brighton one, the actual cost of running bears to the total cost of supply, the author is inclined to think that central station engineers in the past have devoted too much of their time to the reduction of the running costs, and so have been compelled to neglect the important question of how to diminish the much greater standing costs involved in supplying electricity.

Now with regard to the last feature of interest in the Brighton system, viz. the use in the residential districts of low-tension continuous current at light loads, and of high-tension alternating currents at periods of heavy load, the author thinks much credit ought to be given to Mr. Ward Leonard, an American electrical engineer, who pointed out in 1892 that the obvious corollary from the well recognised fact of the low-tension system being most efficient at light loads and the high-tension system at heavy loads, must be that some combination of the two ought to give the greatest efficiency; and it was clear that, providing the details could be satisfactorily worked out as they have now been, it must necessarily be more economical and safer to run only the high-tension alternating system when the demand is heavy, and at all other times to supply the residential districts from the low-tension continuous-current system, than to continue to supply by means of alternating currents when the only reason for their use has ceased to exist, viz. big loads at big distances.

The map exhibited shows the distributing network and where the combined system is used in the northern parts of Brighton. The circles represent the transformer chambers from which the low-tension distributing mains in the streets are supplied at times of high loads, and the circles with crosses the points where the connecting up to the low-tension distributing network takes place on the load becoming small. As meters are now procurable which will register equally accurately with alternating or continuous currents, there seems to the author to be no objection to this combined system; and when it is remembered how the periods of light load on the average last ten times as long as the periods of heavy load, it must be clearly unnecessary to supply by means of the high-tension feeders and transformers, those parts of the town which can be so much more economically supplied by low tension through the ordinary distributing mains.

On concluding this somewhat lengthy paper, the author would like to state that the rapid development of the electric light at Brighton, besides being due to the long advertisement electricity has had here, must be greatly attributed to the splendidly liberal way in which the Brighton Corporation, through the lighting committee, have interpreted their duties as the business managers of the electricity undertaking—in supplying nearly every business street in the Borough, and the principal residential districts, with electricity distributing mains; in recognising at an early date what a big undertaking and financial help to the town it might ultimately become; and the Members, after visiting the works and seeing the extensions in progress there, will in all probability confirm these views.

DISCUSSION.

Mr. T. Walker: I have very great pleasure in moving a vote of thanks to Mr. Wright for his paper on electricity supply. It is rather out of my line, and I do not know if I gather correctly that electricity can be supplied here at 2*d.* per unit, comparing with gas at 1*s.* 3*d.* or 1*s.* 6*d.* per thousand cubic feet. I think if that can be done we shall have to know more about electricity than we do at the present time.

Mr. Knight: I should like to correct Mr. Walker. Electricity at 3*d.* per unit is equal to gas at 2*s.* 5*d.* per thousand feet.

Mr. Walker: The statement in the paper is 2*d.* per unit.

Mr. Wright: Might I explain the apparent discrepancy. One gentleman is speaking of the cost of electricity at 2*d.* per unit, at which price we can supply it at 25 per cent. profit, if the light is used for 12 hours per day; the price quoted by the other gentleman is what we charge customers if they use electricity one hour per day. One is the price we could charge for 12 hours per day, the other the price for one hour per day.

The PRESIDENT: The electric light is very much like the Manchester Ship Canal, it is very much overweighted with capital of account, and what I can gather from the paper is this: if you can utilise that capital you can reduce the revenue charges. I think all the signs show that we are on the quick march towards obtaining the electric light universally.

THE SUPPLY AND DISTRIBUTION OF WATER AT BRIGHTON.

By JAMES JOHNSTON, Assoc. M. Inst. C.E., Corporation Waterworks Engineer.

The district which takes its water supply from the Brighton Corporation lies wholly in the county of Sussex, comprises the parishes of Brighton, Hove, Preston, Rottingdean, Ovingdean, Patcham, Falmer and Hangleton, and has an area of about 18,437 acres. The whole of this district is situated amidst a succession of chalk downs which are quite devoid of rivers or streams upon the surface. No surface stream exists between the Ouse at Newhaven and the Adur at Shoreham, a distance of about 15 miles. The geological formation is almost entirely that of the Upper Chalk, and as the whole of the rainfall, except that given off by evaporation or that absorbed by vegetation, at once percolates into the chalk, agricultural drainage is almost unknown and quite unnecessary. The heaviest rains disappear as quickly as they fall, pass through the pores of the chalk into the fissures, and are carried off by these either into the sea or to burst forth in springs at the base of the chalk escarpment, as at Poynings, Plumpton, Clayton and Shoreham. A notable instance of this is to be seen at the works of the Shoreham Water Company at Spring Dyke, where an immense spring, of the purest fresh water, issues forth at the foot of the chalk cliff and is utilised by that company for the supply of its district. It is also no uncommon sight in walking along the sea shore under the cliffs to see innumerable springs of fresh water trickling down the beach. These springs, however, would appear to give off only a small percentage of the rain at once, the greater portion being retained by the chalk itself, which, acting like a sponge, holds up the water until saturation has taken place. The water would of necessity appear as surface streams were it not for the subterranean passages, so to speak, in the form of the fissures above referred to. These frequently extend from the surface to a very great depth, and are probably due to the action of the water during past ages, and are kept open by its flow. These fissures are almost invariably formed at right angles to the coast line, unless a disturbance of the natural stratification has taken place, but differ considerably in their direction of inclination. They vary in size, but are usually from ½ inch to 3 or 4 inches in width, and are also quite independent of each other. As the pores of the chalk become saturated, the water passes into these fissures and is thus conveyed to the sea or to the springs at the base of the chalk escarpment. The sides of the fissures are worn quite smooth by the passage of the water, and are of a light brown colour, probably due to a deposit from the sandy soil on the surface. It is by the intersection of these fissures by adits or headings driven from wells that the water supply for the Brighton Corporation waterworks district is obtained. The central wells are sunk to a depth equal to about mean sea level, and the adits are driven at that depth and in directions approximately parallel to the coast line, so as to cut the fissures at right angles. These adits vary in size, ranging from 18 feet high by 12 feet wide to 7 feet high by 6 feet wide. Each has a grip cut along one side to convey the water to the pumps at the central wells, in order to keep the workings dry during progress. The roof is slightly arched, but this is not always necessary, as the chalk is so hard that frequently chisels and sledge-hammers are required to burst it, picks not being of the slightest use.

To show the influence of rain upon the subsoil water in this district, the author has prepared the diagram (exhibited), which may be of some interest. The curves in red are constructed from the maximum and minimum gaugings of the depth of water in the Lewes Road wells, for each month from the commencement of 1869 to the end of 1894, and above, in blue, are plotted the total rainfalls for the same months. It will be noticed that as the peaks of the heavy rainfalls in the autumn approach the curves of the height of water in the wells, the latter curves gradually, and often rapidly rise, until the greatest depth is reached quite regularly about four months later, March usually being the month of highest subsoil water. It must, however, be noted that the gaugings of the wells were taken each morning before the engines commenced pumping, and in the evening after they had finished, so that the depths were not those of the subsoil water some distance away, nor what the depths would have been had pumping not been carried on ; but the general rise and fall of the curves may fairly be taken as representing the general influence of the rains upon the height of the subsoil water.

At the Lewes Road Works—situate about 1⅓ mile from the shore—there are two pumping wells 93 feet deep, connected by adits, and leading from these there are about 2152 feet of adits. Two compound beam engines of the Woolf type, capable together of raising to the surface 6,500,000 gallons per day, and steamed from six Cornish and two Lancashire boilers, form the pumping plant.

The Goldstone Works, from which the main supply for many years has been taken, are about 2 miles west from the Lewes Road Works, and about 1⅓ mile from the sea. They are constructed in a hollow, which Mr. Whitaker, the geologist, suggests may have been formed by the flow of the subsoil water. The water, having probably a freer course in that locality than elsewhere, escapes more readily to the sea, dissolving and carrying the chalk away with it, and thus causing the ground above to sink bodily. If this is the case, Mr. Whitaker suggests that the hollow itself is perhaps an indication of the existence of much underground water. Whatever the causes to which this physical feature is due, there is no doubt that a copious supply of excellent water was found. The fissures here differ greatly from those at the Lewes Road Works. At the latter place they are more numerous, though smaller and individually less productive, whereas at Goldstone they are found at considerable intervals, and in some instances yield 1,500,000 gallons per day. The pumping wells are 168 feet deep—connected as at Lewes Road—with about 2530 feet of adits. Here also are two engines of the same type as at Lewes Road, and capable together of lifting to the surface about 7,500,000 gallons per day. These are steamed from six Lancashire boilers of a total of 480 horse-power. These engines, like those at Lewes Road, are erected directly over the wells, which for convenience are elliptical in shape, measuring 12 feet by 8 feet across their longer and shorter axes respectively, the centres of the beams being over the centres of the wells. There are two deep-well pumps at the bottom of the wells, worked from either side of the centres of the beams. These pumps lift to the low service reservoirs adjoining the works, but there are also force pumps driven by the same engines, which take their suctions from the deliveries of the deep-well pumps and lift the water into the various higher reservoirs, to be described later. The exhaust steam is condensed by jet condensers, and delivered into cooling ponds in the grounds of the works.

In connection with the Goldstone Works are smiths', fitters' and turners' shops, in which the whole of the repairs for the various pumping stations are done, as well as all the jobbing engineer's work of the other Corporation departments. In fact, there is no engineer's work necessary to any of the machinery belonging to the Corporation that cannot be executed in these shops. This has proved of considerable benefit, as the work is turned out at less cost than engineering firms could be expected to charge. There is also the advantage of having all necessary lathes, planing and drilling machines, &c. ready to hand for emergencies.

The Patcham pumping station is about 3 miles from the sea front, and on the western side of the London Brighton and South Coast Railway Co.'s main line to London. These works are at the present in course of development, and there is one high-pressure compound surface-condensing engine, geared to drive two sets of three-throw deep-well pumps, which together are capable of lifting 1,500,000 gallons per day into the middle service reservoir at Islingword Road. The pumping well is 175 feet deep to the bottoms of the adits, which at the present time are about 1455 feet in length. The engine is steamed from two Lancashire boilers working at 120 lbs. pressure.

In order to keep the water supply well in advance of the somewhat abnormal increase in the population (due, no doubt, to the close proximity of Brighton to the metropolis), the Corporation has authorised a further extension of the adits, and to this end a new well has been sunk adjacent to the one now in use. There is also in course of erection for this station a very powerful inverted direct-acting three-cylinder triple-expansion surface-condensing engine of the marine type, working one set of three-throw pumps, each being directly connected to one piston rod, and driving also two deep-well pumps by a connecting rod from one end of the crank shaft and bell cranks over the well. This engine will be able to deliver 3,000,000 gallons per day into the highest service reservoir, the total head, including friction in the mains, being 500 feet. Two Lancashire boilers, for a working pressure of 120 lbs., are also on order to augment the existing boiler power.

At the Islingword Road reservoir is one of Bailey's hydraulic motors, driven by passing the necessary water from the high service reservoir at Park Road into the former, from which the motor takes its suction, the difference in levels being 80 feet. This motor delivers either into the highest service reservoir on Race Hill or into the Warren reservoir to supply the Warren

Farm Schools. The exhaust water from the motor is delivered into the Islingword Road reservoir, and thence into the service mains; the only expense, therefore, being that due to pumping the extra water required into Park Road reservoir, together with the repairs, &c. to the motor.

In the foregoing remarks the author has endeavoured to set forth the sources of supply, together with the means adopted for obtaining it, and also the machinery in use. The author now proposes to deal with the distribution and storage.

In consequence of the physical features of the country in which the waterworks district is situated, the system of supply has been arranged in five zones, or service districts, each supplied from separate reservoirs with its own system of mains. By this means the expense of lifting the water higher than necessary, as well as undue pressure on the lead pipes and fittings, has been avoided. Ample pressure is thus provided for each zone, and in case of necessity the water can be let down from the highest to the lowest zone through a system of division valves, the water from the higher reservoirs being prevented from entering the lower ones by self-acting valves placed in each reservoir. Four of the zone districts are each supplied from two reservoirs with mains connecting them, the reservoirs being practically at the same level but one on each side of the town. The Lewes Road and Goldstone engines pump into the reservoirs nearest them, and the water levels balance themselves by gravitation, thus keeping an equal pressure throughout each zone.

The zones are known as the Low, Middle, High, Higher and Highest Service Systems, and the positions, capacities and top water levels of the reservoirs supplying them are as follows:—

Low Service. Two connected reservoirs at Goldstone Works: total capacity 2,100,000 gallons, top water levels 137·00; and one reservoir at Lewes Road Works: capacity 1,000,000 gallons, top water level 132·00.

Middle Service. One reservoir at Nunnery Road: capacity 1,000,000 gallons, top water level 211·50; and one reservoir at Islingword Road: capacity 2,000,000 gallons, top water level 212·00.

High Service. One reservoir at Dyke Road: capacity 1,000,000 gallons, top water level 296·50; and one reservoir at Park Road: capacity 600,000 gallons, top water level 292·00.

Higher Service. One reservoir at Red Hill, Dyke Road:

capacity 500,000 gallons, top water level 400·00; and one reservoir at White Hawk: capacity 500,000 gallons, top water level 397·00.

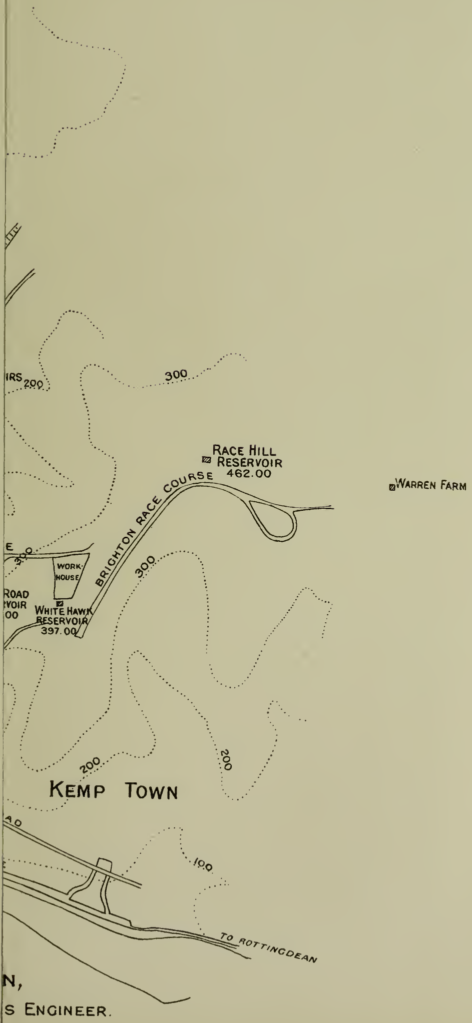
Highest Service. This is supplied from one reservoir only, situated on the Race Hill, north of the grand stand: capacity 600,000 gallons, top water level 462·00.

The total capacity of all the reservoirs is accordingly a little over 9,250,000 gallons, but these are not intended so much for storage as service purposes, the storage being naturally formed in the chalk from which the water is obtained. These reservoirs are built of brickwork in cement, and formed in the chalk. Puddle has not been used, but the insides are lined with two courses of tiles set in neat cement; they are covered in with brick arches 4½ inches thick, which spring from piers and jack arches, and from 12 to 18 inches of mould is laid on the covering arches. By this means the water is kept cool and pure, and the growth of vegetation which so quickly takes place in chalk water when exposed to light and air is prevented. In fact, as has often been stated, from the time of its leaving the adits the water is not exposed to the light until it is drawn from the taps by the consumers.

The quantity of water supplied for all purposes during the financial year ending March 31 last, has been 1,973,000,000 gallons. The population, estimated on the census returns of 1891, is over 150,000; but in the fashionable season of Brighton, and on many other occasions, it is computed that there are in addition from 30,000 to 50,000 visitors. As Brighton is essentially a health resort, the waterworks committee allows the fullest possible use to be made of the excellent water supply by the inhabitants, and the whole of the sewer flushing and street watering is done with fresh water.

On the purchase in 1854 of the Brighton, Hove and Preston Waterworks Company—which was constituted by an Act passed in the year 1834—by the Brighton, Hove and Preston *Constant Service* Waterworks Company, it was found necessary to lay a duplicate set of mains in every street, so as to comply with the statutory obligation to give constant service, the previous company's supply having been only intermittent. This was necessitated through the new company being unable to keep up the supply in consequence of the enormous waste of water caused by the old fittings in the houses.

These old intermittent mains are now to a great extent done away with. The Corporation insists upon a constant supply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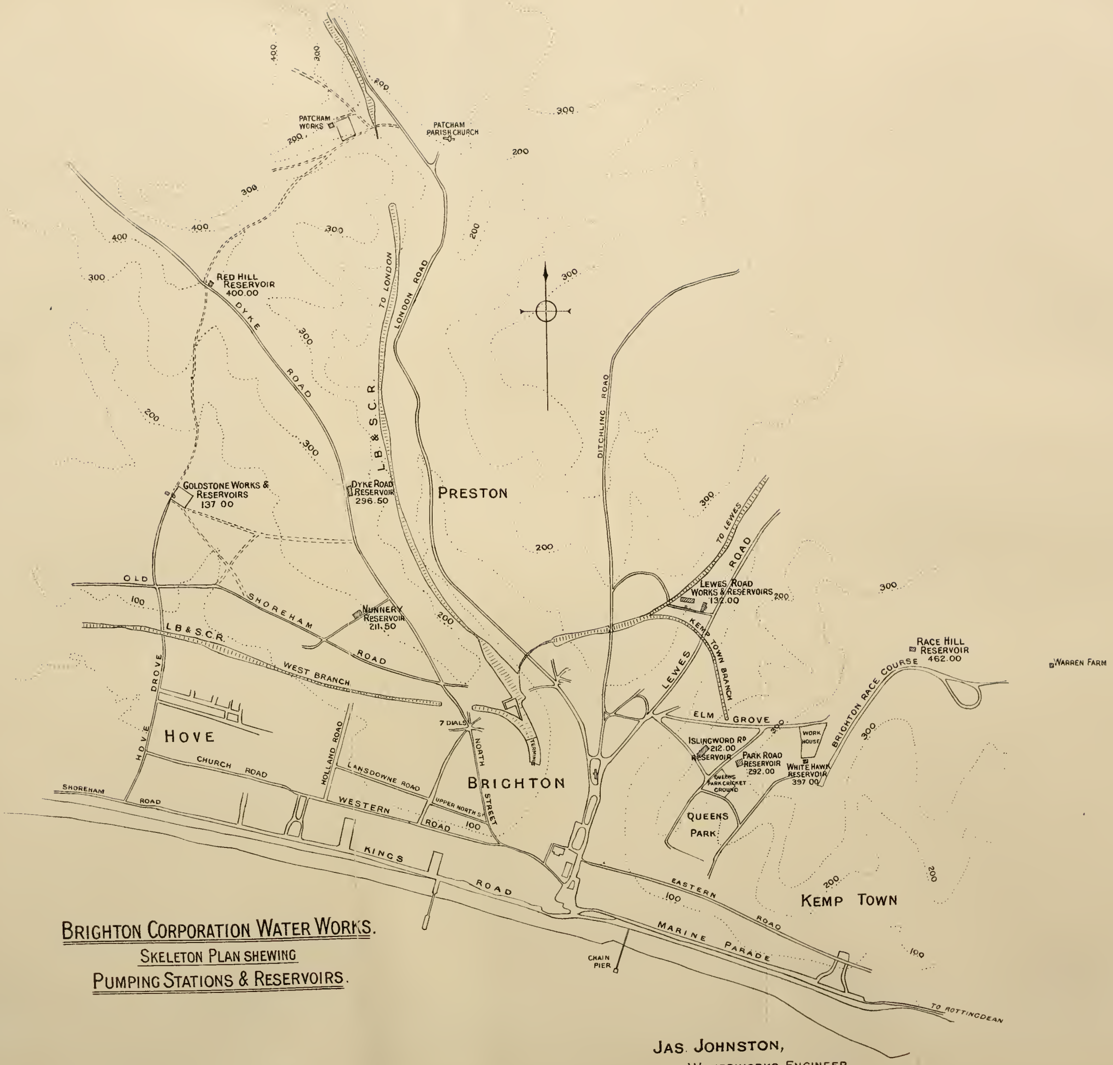

BRIGHTON CORPORATION WATER WORKS.

SKELETON PLAN SHEWING

PUMPING STATIONS & RESERVOIRS.

JAS. JOHNSTON,
WATERWORKS ENGINEER.

being given to every new house, and the few remaining intermittent services are gradually being changed to the constant system. The intermittent mains have either been changed into constant (after the regulations have been complied with as regards house fittings), or taken up or cut off and left "dead" as they fall into disuse.

It is of considerable importance to point out that for fire extinguishing purposes fire engines are quite unnecessary, as by working the division valves a magnificent pressure of water can always be given, and as much as 400 feet can be supplied in many parts of the district by this means. Fire hydrants are fixed at convenient distances in every street, and in some cases special mains have been laid for this purpose.

The charge for water for domestic purposes is 9*d.* in the £ of the Poor Rate Assessment, and by meter on a sliding scale commencing at 1*s.* 3*d.* and ending at 7*d.* per 1000 gallons, in addition to a small rental for meter; a minimum charge, however, being made of 5*l.*, for which 80,000 gallons are allowed. Water is supplied to the local authorities at 5*d.* per 1000 gallons.

Although the charge in all cases for domestic purposes is amongst the lowest in the United Kingdom, it is gratifying to point out that after paying the interest on capital, providing the necessary sinking fund and paying working expenses, a balance has remained for several years past of 6000*l.*—and this year it is estimated to be over 7500*l.*—which has been transferred by the Waterworks Committee to the Borough Fund in aid of the Borough rate.

The expenditure on Capital Account on the 31st March 1894, was about 524,000*l.*, the Waterworks Debt 503,776*l.*, and the Contingent Fund at that date amounted to 15,663*l.* The total income for the year 1893–4 was 47,995*l.*, and the Sinking Fund available for the reduction of the Waterworks Debt was nearly 4000*l.*

The waterworks undertaking was carried on until 1872 by the Brighton, Hove and Preston Constant Service Waterworks Company, in which year it was purchased by the Corporation of Brighton for 321,156*l.* 11*s.* 8*d.*

The first company took its supply from a well and bore hole near the existing wells at the Lewes Road Works, but after the purchase of this company in 1854 by the predecessors of the Corporation, new wells were sunk close by and adits driven which were extended as the demand for water increased. These continued to supply the district until 1865. In that year the Goldstone Works were commenced by the sinking of one well and about a quarter of a mile of adits being driven. These in turn were also extended as occasion required, and with the Lewes Road Works, provided the whole supply until some three years ago, when the present machinery and works at Patcham became available.

The whole of the earlier works were designed by and constructed under the late Mr. James Easton, who was succeeded later by his son Mr. Edward Easton. The latter gentleman continued for many years after the purchase by the Corporation to act as consulting engineer, and to his skill and great engineering abilities the later developments are due.

DISCUSSION.

Mr. Lowe: I have much pleasure in proposing a vote of thanks to Mr. J. Johnston for his paper on the supply and distribution of water. It is a paper which must be most interesting to all waterworks engineers. What particularly struck me, as a Metropolitan engineer, was that Brighton is giving every consumer a constant supply, and I can only hope that the metropolis will be equally fortunate at some future time.

The vote of thanks was accorded with unanimity.

The President: I have a very pleasing duty to perform, that is to thank the Mayor and the Members of the Pavilion Committee for the use of this handsome suite of rooms. They are almost palatial; and it is not often that we have rooms of this grandeur placed at our disposal. I am sure we are grateful to the Mayor for allowing us the use of these rooms for our meeting. Wherever the Association go we are received with the very greatest kindness by the municipal authorities, and the Corporation of Brighton have not been behind other towns in extending to the Members of the Association a hearty welcome.

The vote of thanks was unanimously adopted.

The Members were entertained to luncheon by Mr. T. Wilkinson in the banqueting hall of the Pavilion. The party then drove in brakes to inspect the new Swimming Bath in Barrack Yard, the Electricity Station in the North Road, the Storm-water Outfalls *at the Norfolk Groyne and the Albion Groyne, and the new Abattoir, works which have been referred to in the papers read. Time, however, did not permit of visits to all which it had been proposed to see. The Members returned to the Pavilion, where they were entertained to tea and light refreshments by the Borough Engineer.*

DISTRICT MEETING AT CARDIFF.

May 11, 1895.

Held in the Council Chamber of the Town Hall, Cardiff.

A. M. FOWLER, PRESIDENT, *in the Chair.*

THE Mayor, in welcoming the visitors, said that his pleasure in receiving them on behalf of the Corporation of the town was accentuated by his recollection of the fact that the President of their Association was connected with Cardiff some forty years ago. The efforts of the borough engineer had been so valuable to the town, that when Mr. Harpur mentioned that the Members of the Association were coming to Cardiff, he (the Mayor) felt sure that he would only be emphasising the wishes of the Corporation and citizens in heartily welcoming a body of men who were of such usefulness to the kingdom, and who did such good work in advancing sanitary science and improving the health of the people.

Mr. W. E. C. Thomas was unanimously re-elected Honorary Secretary for the South Wales District.

The following paper was then read:—

SOME OF THE RECENT PUBLIC WORKS OF CARDIFF.

BY WILLIAM HARPUR, M. INST. C.E.,
BOROUGH ENGINEER.

IT would be almost impossible in a paper of the length permissible upon an occasion like the present, to embody even briefly the many interesting features in connection with the modern municipal history of Cardiff. The author must therefore confine his remarks to a few general statistics in reference to the development of the Borough, and then deal briefly with the works to be visited.

POPULATION.

The population of Cardiff in 1871 was 56,911; in 1881, 82,671; in 1891, 128,849; in 1895, it is 155,637.

Time will not here be wasted in comparing this increase of population with that of other large towns. That may be done by any Member of the Association who wishes to make comparisons; but taking the population of 1885, viz. 97,034, and comparing it with the population of this year it shows an increase in the ten years of 60·39 per cent.

HIGHWAYS.

When the writer first became connected with municipal work at Cardiff, 19 years ago, the total length of highways repairable by the Corporation was 32 miles, which included 9 miles of old turnpike roads which had been taken over and disturnpiked on January 1, 1876. The length of highways now repairable by the Corporation is 97 miles.

During the past ten years private improvement works have been executed in 268 streets, having a length of 29½ miles, at a cost of 103,710*l*.

In addition to the 97 miles of public highways, there exists in the Borough many miles of private roads of the Bute Docks Company in connection with their docks undertaking, and of Lord Bute and other landowners, and also many miles of private streets recently laid out for building purposes, and which will in due course come into the hands of the public authorities as the buildings are erected and the private improvement works are executed.

BUILDINGS.

The author would venture to assert that there is no town of equal size in the United Kingdom, which during the past ten years can show such activity in the building trade as that of Cardiff, particulars of which are given in the table of plans which have been submitted to and approved by the Public Works Committee from 1885 to 1894 inclusive, and are as follows :—

Year.	New Streets.	Houses and Shops.	Places of Worship.	Schools.	Other Buildings.	Totals.
1885	49	1,345	2	..	256	1,652
1886	31	1,201	11	..	216	1,459
1887	18	1,126	5	1	189	1,339
1888	3	1,062	6	..	183	1,254
1889	8	603	4	..	159	774
1890	18	745	4	3	155	925
1891	6	730	6	3	167	912
1892	23	950	4	1	199	1,177
1893	14	1,456	7	3	303	1,783
1894	20	1,255	7	6	204	1,492
Totals ..	190	10,473	56	17	2,031	12,767

Upon information like the foregoing, and which is undeniable, Cardiff may justly—as she does—claim to be the most rapidly increasing town in the United Kingdom, and to rank amongst the most prosperous towns in the world.

In referring to public works the author will only deal with those constructed during the past ten years, and those only with which he himself has been identified as engineer.

SEWERAGE WORKS.

During the past ten years the sum of 58,701*l.* has been expended upon sewerage works in the Borough; of this sum 29,246*l.* was spent in providing a new system of sewerage for the eastern part of the Borough—Roath, and consisted chiefly of outfall works at the mouth where the sewage discharges into the Bristol Channel, 1960 lineal yards of 6 feet diameter sewer; 950 lineal yards of 4 feet diameter sewer; 1650 lineal yards of 3 feet 9 inches by 2 feet 6 inches egg-shaped sewer; 1973 lineal yards of 3 feet 3 inches by 2 feet egg-shaped sewer, and the various works contingent thereon.

The remaining 29,455*l.* has been expended principally in reconstructing sewers in Temperance Town, Bute Town, Herbert Street, Tyndall Street, Richmond Road, and a portion of the district of Canton.

Sanction of the Local Government Board has been obtained to the borrowing of 16,500*l.* for enlarging 780 lineal yards of sewer to 10 feet in diameter, and 447 lineal yards of sewer to 5 feet by 3 feet 4 inches egg-shaped in Swansea Street, Singleton Road and Adeline Street, and works in connection therewith, and these works will shortly be commenced.

Street Improvements.

In the matter of public street improvement works of various kinds in addition to those specially referred to herein, the Corporation has since 1885 expended the sum of 88,565*l.*, and in the Cardiff Corporation Act, 1894, they have power to execute 27 road, street and bridge improvements, and to borrow the sum of 235,000*l.* therefor.

The Corporation has determined to relay the footways of several of the main thoroughfares of the town, and to pave the carriageways partly with granite setts, but mainly with Australian hard-wood blocks, and have obtained the sanction of the Local Government Board to borrow the sum of 30,548*l.* for carrying out the work.

It is rather unfortunate that in anticipation of this work the foot pavements on both sides of St. Mary Street and High Street, as well as the carriageways, are being torn up for the purpose of laying down new gas and water mains, thus giving the streets anything but a good appearance at the present time.

Bridges.

In addition to the erection of the Clarence Bridge over the river Taff—which will be more fully described later on—and the James Street Bridge over the Glamorganshire Canal, in connection with the same scheme, the Corporation has in the past ten years expended a no less sum than 41,673*l.* in constructing, widening and improving 13 road bridges crossing under or over the various railways in the Borough.

Nothing perhaps points more conclusively to the marvellous development of the town than the necessity for so large an expenditure on the bridges of the various railway companies, converting what were either dirty cattle creeps 10 or 12 feet wide and 8 or 9 feet high, or common parish road bridges of 25 or more feet span, into bridges more in accord with the requirements of the traffic and more creditable to the general appearance of the town, thus providing bridges of 40, 50 or 60 feet in width, as the exigencies of the case demanded, or as could be secured.

Clarence Bridge and Roads.

This bridge was so named by the late Duke of Clarence and Avondale, in honour of His Royal Highness performing the opening ceremony on September 17, 1890.

Prior to the construction of this bridge the traffic of that part of the Borough was conveyed over the river Taff by means of a private bridge, the property of the Penarth Harbour, Dock and Railway Company, then existing across the river Taff at a point about 350 yards lower down the river than the new bridge.

By the powers of the Act of Parliament under which such last-mentioned bridge was constructed, the Company were entitled to collect tolls from all persons using the bridge, but for many years after its erection the tolls collected would not have amounted to the wages of the toll collector, and in consequence the public were allowed the free use of the bridge until the spring of 1886, by which time the tolls would return a handsome revenue.

In the meantime a large number of workmen's cottages had been erected on the western side of the river, the owners being totally in ignorance of the possibility at any time of the imposition of a toll for crossing the bridge.

Upon the toll being first imposed, the public using the bridge were greatly annoyed and refused to pay the demand, and taking the law in their own hands on two occasions, broke down the gates and threw the collector's lodge into the river.

The Corporation endeavoured to intercede and to make terms with the Company for the purchase of the bridge as public property, but failed in their negotiations; upon which it was determined to seek powers for the construction of a new public bridge, which they did in the next session of Parliament, and in 1887 obtained an Act authorising the construction of the new roads and bridges.

The Clarence Bridge forms the principal feature of the works carried out under the powers of the Cardiff Corporation Act, 1887. The works comprise the formation and construction of about two-thirds of a mile of new roads 50 feet wide, half a mile of roads

40 feet wide, a bridge over the river Taff 464 feet long, and one over the Glamorganshire Canal 104 feet long, and form a better and more direct communication between the commercial part of the town in the neighbourhood of the Bute Docks, and the rapidly increasing suburbs of Grangetown and Canton.

The roads on the western side of the river are formed by embankments, for the purpose of preventing the recurrence of the flooding by tide of the low-lying district of Grangetown, and being mostly constructed on the river side of the existing sea bank a large area of land has been recovered by their construction. In constructing Avondale Road, the salt marsh was so soft that it was found to be impossible to form the embankment in the usual way, as all the material deposited sank below the surface and spread laterally. The difficulty was, however, overcome by forming the embankment on a cradle of timber baulks and brush wood the full width of its base; by this means the material was prevented from spreading sideways, the cradle sinking with the superimposed weight until a foundation hard enough to support the embankment was reached.

The Clarence Bridge spanning the river Taff comprises a central swinging span of 190 feet 8 inches, providing two openings, each of a clear width of 72 feet, for the passage of vessels navigating the river, and two end fixed spans, each 132 feet from centre to centre of end pins.

The river bed consists, at the site of the bridge, of a stratum of gravel about 32 feet in thickness overlying a bed of marl. Large deposits of mud washed up by the tide cover the gravel, except in those portions where the current is strongest; the positions and depths of these deposits constantly varying. The foundations of the abutments are carried down to a depth of 6 feet, and the piers to an average depth of 12 feet, below the lowest point in the river bed, and were obtained, in the case of the abutments, by the use of close timbered excavations, and for the piers by the use of wrought-iron caissons, sunk into the gravel by excavating from the inside; a ring of masonry was built upon the caisson as the sinking proceeded, and when the required depth was reached the bottom was carefully levelled, and the whole filled with cement concrete; the caisson thus forming part of the permanent structure. In the case of the side piers the sinking was done under water by means of a dredging grab, but for the central pier the water was pumped out and the excavation executed in the dry. The central pier, upon which the swinging span is supported, was, on completion, subjected to a test load consisting of 1000 tons of iron rails. This load was 30 per cent. more than the calculated maximum weight that the pier has to support, and the result was very satisfactory, the pier sinking at the most only $\frac{5}{16}$ inch. Timber dolphins, composed of creosoted pitch pine baulks, driven 9 feet into the river bed and braced together, are placed up and down stream to protect the ends of the bridge, when open, from collision with passing vessels. The abutments and piers are built of Pennant stone from the Newbridge quarries, having string courses, copings and bedstones of grey Cornish granite.

The superstructure is of mild steel, with the exception of the longitudinal flooring girders, diagonal bracing between same, the buckled flooring plates and parapets, which are of wrought iron. The 12-inch channels, the diagonal ties, and the 10-inch links forming the flanges of the main girders were rolled by the Steel Company of Scotland, while the remainder of the steel was supplied by the Steel Company of Staffordshire. An interesting fact in connection with the manufacture of the steel eye-bars forming the diagonal ties in the main girders, is that the builders found it more convenient to have the heads forged on them in America than to get the work done in this country, the bars being shipped direct from the rolling mills in Glasgow to New York, and back by way of Liverpool.

The bridge is 40 feet wide from centre to centre of parapets, and consists of a carriageway 24 feet wide in the clear, and two footpaths supported on cantilevers on the outside of the main girders, each 8 feet wide. The main girders are pin-connected trusses with single intersection quadrangular web bracing; those for the fixed spans are of a uniform height of 17 feet from centre to centre of pins, while those for the swinging span are 17 feet high at their extreme ends, rising by an upward curve to 25 feet over the centre pier. They are braced together overhead, giving a clear headway for carriage traffic of 16 feet.

One great advantage of this open system of web bracing in the main girders is that the footpaths are not thereby severed from the carriageway, but free access is obtained across the bridge from parapet to parapet. This convenience, though of little moment in the case of a short bridge, must be appreciated in the case of a long one such as this. The whole of the weight of the swinging span, which is upwards of 500 tons, rests entirely on the centre pier, not only when the bridge is swinging, but also when closed and ready to receive the road traffic. It is believed that this is the first swing bridge constructed upon this principle in the United Kingdom, the usual method being to raise the ends of the span by cams, wedges, or other mechanical device, so as to bring the main girders into the condition of stress obtained in a continuous girder resting on three supports. It is also believed that at the time of opening for traffic it was the largest swinging road bridge erected in the country. The bridge is designed to carry the heavy traffic of the neighbourhood, such as a load of 30 tons on a four-wheeled trolley. The carriageway is paved with creosoted wood blocks on a concrete foundation, and the footpaths with "Adamantine" concrete paving. Wooden turnpikes on the carriageway, and gates on the footpaths arrest the traffic during the swinging of the central span, which can be accomplished by four men in five minutes.

The masonry piers and abutments and the timber dolphins were executed by Messrs. Logan and Hemingway, and Messrs. Handyside and Co. of Derby manufactured and erected the superstructure.

The cost of the whole undertaking was 53,150*l.*

St. Mary Street Market Hall.

The foundation stone of this building was laid by Alderman D. Edgar Jones, M.D., on August 7, 1890, and the opening ceremony was performed by the Mayoress, the Most Honourable the Marchioness of Bute, on May 8, 1891. The new building stands on the site of the Old Market Hall, which was erected in the year 1836.

The site upon which the structure stands is somewhat irregular in shape, and upon a reference to the ground plan it will be observed that out of this irregular-shaped site a rectangular hall has been formed of about 200 feet by 81 feet, leaving spaces on either side of varying widths, which are covered with flat asphalted roofs, forming butchers' shops on the ground floor and shops for the sale of sundry goods on the gallery floor. The flat roof is also carried at the same level along the ends of the main building, which arrangement has one obvious advantage, viz. that of allowing of the introduction of a belt of clerestory windows over the gallery shops, which are again surmounted in the case of the gables by glazed screens. At the eastern end of the site a fish market has been formed, about 87 feet wide and a mean depth of 28 feet, divided off from the general market by a 14-inch brick wall, and covered by an iron-framed roof in three spans.

Steel and ironwork have been introduced largely in the formation of the large rectangular hall, the framework of this portion of the building consisting of cast-iron columns dividing the shop fronts, and surmounted by a steel and iron-framed roof in one span.

The main columns are placed 24 feet 6 inches apart, centre to centre, and evenly spaced between these are light cast-iron stanchions of square section, with projecting ribs to receive the ends of the half-brick partitions between the butchers' shops. These stanchions also support the longitudinal gallery girders. As the same amount of accommodation was not required in the gallery shops as in the butchers' shops below, the wrought-iron stanchions which support the main roof, instead of being fixed directly over the ground floor columns, are set back at a distance of 2 feet 6 inches and are carried by wrought-iron transverse girders, one end of which is built into the outer wall, while the other end is continued over the head of the column in the form of a tapered cantilever. Rolled steel joists connect the outer ends of the cantilevers, and form a continuous fascia to which the gallery parapet is secured.

The principals of the main roof are simple Belgian trusses, having rafters composed of wrought-iron lattice girders 1 foot 8 inches deep, riveted together at the crown by solid wrought-iron web plates. The foot of the rafter has also a solid web, and is strengthened by the addition of an extra flange plate on the top, and on the other side by the two angle irons forming the flange of the spandril bracket. The struts are formed of four angle irons back to back, with distance pieces riveted together at intervals; the top of the strut is formed by turning the angles two up and two down the rafter for a short distance, and inserting malleable cast-iron brackets, while a suitable forging at the foot of the strut connects it to the ties by means of a turned pin. The ties consist of flat steel eye-bars, such as are used in pin-connected bridge girders; these bars were rolled by the Steel Company of Scotland, and sent to New York to have the eyes formed on them by a system of upsetting the end of the bar, as in the case of the ties of the Clarence Bridge. A little ornamental scrollwork at the foot of the king rod relieves what is otherwise the most bare and awkward looking connection in the truss.

The purlins are formed of lattice girders corresponding in depth to the principal rafters, such girder being divided into three bays by two intermediate rafters consisting of two angle irons placed back to back, riveted together by $\frac{3}{8}$-inch washers between, at intervals of about 2 feet. The ventilator framing is of light angle iron with malleable cast-iron fillings. The vertical lantern lights are all hung on pivots at the centre, and a flat gangway covered with lead is provided along each side of the ventilator from which the lights can be opened as required. The gangway is also useful for giving access to the ventilator for repairs, &c., avoiding breakage of slates which so often occurs when workmen have to traverse the slating.

The girders forming the rafters of the gable screens are of "box" section composed of two ribs placed 18 inches apart, the inner rib having a lattice web similar to the ordinary principals, while the outer one has a solid plate web. These two ribs are placed together on the under side by lattice bars, and on the upper face by a lacing of somewhat wider bars. The end ventilator principal is similar to the ordinary ones and rests on the inner rib of the gable rafter, this arrangement making all the connection of purlins, &c., to the gable principal the same as the ordinary ones. The horizontal tie girder forming the base of the gable screen is also of box section, with two solid plate webs, the upper and under sides being composed of latticework. The vertical members of the screen are composed each of two T-irons with light lattice webs, and the horizontal members are formed of angle irons stiffened by an arched cord. The whole forms a very rigid structure, well adapted to resist wind pressure. The gables and skylights are glazed, Heliwell's patent system of glazing having been adopted for the purpose.

The central row of provision shops is constructed entirely of wood. An office for the market superintendent occupies a position in the centre of the market, and has its floor level with the tops of the adjacent provision shops. It has windows on all sides. A clock turret has been erected on the roof of the office, fitted with a first class clock, which shows the time on four dials 2 feet 6 inches in diameter. The space under the office is used for the accommodation of public weighing machines. The flooring of the avenues and the gallery is executed in "Adamantine" concrete paving, the speciality of Mr. James Hartnell, of Cardiff.

The ground floor paving has a fall of 6 inches from the centre to the sides of the building, and cast-iron hollow channels with movable chequered covers are inserted in the floor at the edges and connected at intervals with the drains so as to carry off all water after the market has been washed down. In the fish market, where water is, of necessity, used more frequently, perforated gratings take the place of the movable chequered covers, thus allowing water to pass freely away at all times.

For taking up goods to the gallery a hydraulic lift has been provided in one corner of the building, the motive power being obtained from the town mains. The lift is of the direct-acting type, capable of lifting 5 cwt., and was supplied and erected by Messrs. R. Waygood & Co., of London.

Messrs. A. Handyside & Co., of Derby, were the contractors for ironwork, and Mr. James Allan, of Cardiff, the contractor for the general builders' work. The total cost of the market was 17,061*l.*

Electric Lighting.

As in other public matters, Cardiff has not been behind in providing itself with the electric light. The proposal having engaged the attention of the Council during 1890 and 1891, a provisional order was obtained by the Council in 1892, enabling them to provide the requisite buildings, machinery and requisites for enabling them to supply electrical energy to any part of the Borough.

In the matters of electrical plant, machinery, &c., the author was assisted by Mr. W. H. Massey, M. Inst. C.E., M.I.E.E., of 25 Queen Anne's Gate, Westminster, who acted throughout as consulting engineer, and to him must be given any credit due to the efficiency of the plant and machinery, and to the excellency of the whole system of electric lighting.

The whole of the work in connection with the erection of the buildings, however, has been carried out by the author, as well as the supervision of the laying down of the street mains, and the erection of the whole of the plant.

The station is situate on land which belonged to the Corporation and formerly comprised a part of "Canton Common," about $1\frac{1}{4}$ miles from the centre of the town. The site set apart for electric lighting purposes is large enough to permit of the station being extended four times the size of the buildings now erected.

The station covers a space of 80 feet square. The engine and dynamo room is 80 feet by 30 feet, the boiler house 80 feet by 30 feet, and the coal bunkers 60 feet by 14 feet.

The chimney stack, which is 150 feet high from the ground level, is octagonal in plan. The internal area is 64 superficial feet. The brickwork at the base is 4½ bricks thick, and at the top is 1½ brick thick, and is surmounted by a heavy grey Cornish granite capping, the last stone of which was laid by the chairman of the Lighting Committee, the late Mr. Councillor W. E. Vaughan, J.P., on October 17, 1893. The cap is formed in eight stones bound together with copper cramps. The chimney is built of Ebbw Vale bricks faced with buff pressed bricks and relieved by red bands, and is lined to a height of 40 feet with fire-bricks, and a cavity has been left between the outer brickwork and the fire-brick lining; the foundations of the chimney extend for a depth of 20 feet below the ground level.

The exterior of the buildings, and also the inside of the engine house walls, are also faced with Ebbw Vale buff pressed bricks relieved by red bands, and the stone used for the sills and gables is from the Forest of Dean Quarries.

The cost of the buildings and chimney was 5473*l.*, exclusive of boundary walls, gates, engine and boiler foundations, flues, &c., which cost an additional 2400*l.* The contractors for this portion of the work were Messrs. W. Thomas & Co., of Cardiff.

The system of plant adopted is a high-tension alternating current system with rectified current for the street arc lamps.

There are at present three boilers in position, and these are of the "economic" marine type, constructed for a working pressure of 160 lbs., and are made by Messrs. Davy, Paxman & Co., of Colchester. All the steam and exhaust pipes are of copper.

Four engines and alternators have been erected to commence with; two of these are vertical triple-expansion condensing engines, each of 270 brake horse-power, and running at a speed of 133 revolutions a minute; the others are of the vertical compound condensing type, each of 65 brake horse-power, running 200 revolutions a minute. These engines are by Messrs. Davy, Paxman & Co., and were supplied through Messrs. Siemens Brothers & Co., the contractors.

The condensing plant has been supplied by Messrs. James Watt & Co., of Birmingham, and comprises a surface condenser having 1000 lineal feet of tube surface, and is fitted with duplex double-acting air circulating pumps, capable of raising 25,000 gallons of water per hour a height of 15 feet.

Each of the four engines is coupled direct to one of Messrs.

Siemens' alternators. The exciters for the alternators are coupled direct to an extension of the armature shafts, so that each direct-coupled shaft comprises engine, alternator and exciter.

The engine house is provided with an overhead travelling crane capable of lifting a weight of 10 tons, and was supplied by Mr. Thomas Smith, of Rodley, near Leeds. It has single and double-purchase gear to suit varying loads, and is provided with a powerful friction brake and a safety catch.

The whole of the high and low-pressure street mains, which are laid in cast-iron pipes, are of the concentric type made by the India-rubber, Gutta-percha and Telegraph Works Co., Limited, of Silvertown, London, and have specially thick insulation.

The current is brought from the station to the town by two high-pressure feed mains at 2500 volts, and is there transformed by means of 6 transformers to 105 volts, at which pressure current is supplied to consumers.

The street transformers are by Messrs. Siemens, and are placed in iron cases under the street pavements.

For the street arc lighting a high-tension feed branch is taken into the basement of the Town Hall and there transformed down to 600 volts by means of Ferranti transformers, and rectified to a direct current by means of Ferranti rectifiers, and supplied to the street lamps through 4 feed mains each supplying 12 lamps. The lamps are supplied from alternate circuits, so that in case of a break-down in any arc main or in one of the motors every alternate lamp is kept burning and is able to maintain a fair light in the streets.

The streets are lighted by means of 48 Siemens' band arc lamps, in lanterns by Davis, of London, and the columns are by Messrs. Macfarlane & Co., of Glasgow; the height from the street to the "arc" is 22 feet.

The whole undertaking in connection with the electric lighting has cost about 32,000*l*., and extensions are now in contemplation.

THE SANATORIUM.

The site is about 12 acres in extent, including 2 acres now occupied by the temporary structure, and is situate on the Canton Moors near the western boundary of the Borough.

The entrance is at the north-west corner of the site, and to the left of the gateway will be the porter's lodge, which it is intended to build at some future time.

The buildings are eight in number, the administrative block, two main ward blocks, isolation block, laundry block, stable, disinfecting house, and mortuary.

The administrative block is the only one of the buildings which is three stories in height, the rest being one story, with the exception of the stable block, which has two floors.

The administrative block contains on the ground floor, matron's room, doctors' room, bath room and lavatory, dispensing room, visitors' room, nurses' dining room, linen closet, matron's stores, general stores, kitchen, scullery, servants' dining room, staff ironing room, drying closet and washhouse, pantry, china closet, dairy, coal and wood stores, &c.

The kitchen is fitted up with cooking range, griller, cooking pans, sinks, hot closet, carving table, and dressers; and the scullery is arranged with porcelain sinks, potato steamers, plate racks, &c.

The staff washhouse and laundry contain washing troughs, rinsers, hydro-extractor, mangle, stoves, &c.

There are three staircases: the main staircase in the entrance hall, the nurses' staircase, and the servants' staircase, which is at the back of the building adjoining the kitchen.

On the first floor there is a nurses' sitting room and 15 bed rooms, and on the second floor 19 bed rooms; bath rooms, lavatories, and water-closets are also provided on the first and second floors for the use of the staff.

The floors of the sitting rooms and dining rooms are boarded, whilst the hall, kitchen and passages are laid with marble mosaic, the scullery and washhouse being laid with cement concrete.

The wards are erected on the pavilion principle: there are two large wards in each main block, one for males, the other for females, each being 60 feet by 26 feet, and two small wards for special cases, each 12 feet by 12 feet and 14 feet high, the total number of beds thus provided being 44.

Between the wards in each block there is a nurses' kitchen and duty room, with inspection window looking into each ward, so that the nurse has perfect control over the wards from her duty room.

At the end of each main ward are the water-closets, sinks and bath room, cut off from the building by a ventilated lobby; and adjoining each of the main wards is a verandah with French casement windows opening on to same.

In connection with the main wards there is a waiting room, and also a bath room with two dressing rooms for discharging patients, which will enable each patient on being discharged to leave the building directly from the bath room without having to re-enter the ward after the final bath.

The isolation block is divided into two equal parts by a wall, and the arrangements on one side of the wall are an exact counterpart of those on the other.

Each of the larger isolation wards is 23 feet by 15 feet, and the smaller wards 14 feet by 14 feet, all 12 feet high, providing in all, accommodation for six beds.

Between the wards will be the nurse's duty room, with inspection windows as in the main wards, and adjoining will be water-closets and slop sinks, also bath rooms with space for movable baths.

The windows, which form the chief means of ventilation to all the wards, are divided into two parts by a transom rail about 1 foot 6 inches down from the head of the frame. Below the transom are ordinary double-hung sashes and frames, but above the transom hopper lights have been provided hung on hinges and falling inwards.

In addition to the ventilation provided by the windows, hit and miss ventilating grids are fixed immediately above the floor level, and Tobin's inlet tubes about 6 feet high.

Ventilating trunks are fixed in the ceilings connected to Shorland's extract ventilators on the ridge for carrying off the vitiated air.

The wards, besides being heated by steam, are also provided with Shorland's patent Manchester stoves and grates, which have an air chamber supplied with fresh air from the outside, and thus the air before passing into the room is heated.

The wards, nurses' room, bath room, &c., have no sharp corners or angles, all window angles being bull-nosed, the angle between floor and skirting being formed with a rounded scotia, and that between ceiling and wall with a plaster cove.

The vertical internal angles of all walls are coved, also all angles of door panels and windows are rounded, no fillets being used, so that dust can easily be removed.

Owing to the exceptionally low situation of the site the whole of the floors have been kept 6 feet above the ground level, and the floors and main walls of the wards are carried on piers and arches, so that there is a through current of air under the floors which will not be liable to be affected by damp.

The floors of the wards are constructed of cement concrete carried on steel joists and finished with oak blocks, whilst the floors of the verandahs, water-closets and bath rooms are similarly constructed but finished with marble mosaic.

The whole of the wards are connected with the administrative block by means of covered corridors.

The laundry block contains a washhouse and finishing room, drying closet, engine house, boiler house and coal stores.

The chimney is 70 feet high and 2 feet 3 inches internal size, and adjoining it is an incinerator for the purpose of destroying bedding, bandages, poultices and other seriously infected articles.

The washhouse is fitted up with steeping tanks, clothes bins, washing machines and troughs, soap boilers, rinsers, boiling tanks, and hydro-extractors, whilst the finishing room is arranged with ironing stove, rolling-in table, ironing boards, &c.

The boiler house contains two steam boilers 21 feet long by 5 feet diameter, which supply steam to work the laundry engine, &c., and for heating, cooking, laundry purposes, disinfecting, and baths throughout the administrative block and all the wards.

The stable block has two stalls, loose box, harness room and van shed, with washing yard in front, whilst over the stable is a hay loft and corn stores.

The disinfecting house has two compartments, the one for infected clothing and the other for disinfected articles, and in the division wall is built one of Washington Lyons' largest sized patent steam disinfectors, so that the articles having passed through the stove and been disinfected do not again come in contact with the infected clothing.

The mortuary is placed at the extreme south-east end of the site, and contains two rooms for stretchers and tables, post-mortem room and pathological room.

The post-mortem room is lighted from the roof and is provided with cupboards, sinks, lavatories and revolving slate slab for dissecting purposes.

The drains are laid with glazed stoneware pipes jointed with cement, and have manholes at each junction and change of direction.

At the head of the drains to each main ward and to the administrative block, one of Field's patent automatic flushing tanks has been fixed; the bath waste is connected to the tank and used for flushing purposes as well as the ordinary supply.

The buildings are plain in design, faced with Ruabon buff bricks above the plinth level, relieved by red bands and Forest of Dean stone dressings, the rubble masonry under the plinth being built in blue Pennant stone, whilst the roofs are covered with Bangor slates capped with red ridge tiles.

Space is reserved on the present site for five more main ward blocks and one isolation block, which would provide accommodation for 116 additional patients.

The contractors for the work are Messrs. Turner and Sons, builders, of Cardiff, and the cost of the buildings and furnishing will amount to about 37,000*l.* exclusive of the cost of the land.

The laundry machinery, boilers, kitchen appliances, &c., have been supplied by Messrs. Bradford & Co., Salford, who have also carried out the steam heating of the wards.

The foundation stone was laid by Alderman Jacobs, J.P., on the 7th of June 1893, and the building will be opened for the reception of patients in about six weeks' time.

Bute Street Police Station.

This station is designed to meet the requirements of a very populous district in the neighbourhood of the docks, and completes a series of district stations in the Borough; previously erected stations being situated at Roath, Canton, Grangetown, Cathays and the East Moors.

The building consists of three stories, and comprises on the ground floor the police administrative department with main entrance from Bute Street, six cells, accommodating twelve prisoners, fire-engine shed, mortuary and dogs' home; the two upper floors consist of a private residence for the sergeant in charge, and quarters for the accommodation of eight single constables.

The exterior is faced with Ruabon brick, the dressings being of Carlisle red shawk stone and terra-cotta. A liberal use has been made of white glazed bricks in the interior, both the walls and arched roofs of the police cells and cell corridor being faced with this material.

Special attention has been given to the warming, ventilating and sanitary arrangements. The cells are warmed by hot-water coils laid in chambers in the floor under the cell beds, the fresh air being brought in and passed through the coil chamber into the cell, the foul air being extracted through gratings in the ceilings connected by suitable flues to air-pump ventilators in the roof.

The whole of the work is being carried out by Messrs. W. Thomas & Co., at a contract price of 4775*l.*

GUILDFORD CRESCENT BATHS.

These baths are being built upon the site of baths previously owned by the Corporation, which have been entirely demolished with the exception of the Turkish bath and manager's residence, and which occupy one corner of the site.

The baths form a portion of a proposed scheme for providing the inhabitants of the Borough with a complete suite of public baths, consisting of a central establishment where the swimming bath will be the chief feature, and a number of subsidiary baths, one in each of the outlying districts of the town, where, together with the provision of a small swimming bath, there would be an installation of private baths for ablutionary purposes.

Owing to the difficulty of procuring a suitable site, the construction of the central establishment has been deferred, and the Guildford Crescent site has been utilised for one of the proposed subsidiary baths.

The establishment consists of a first-class men's bath in direct communication with the Turkish bath, a second class men's bath and a ladies' bath, together with the necessary appointment of ticket office, attendants' rooms, towel laundry, engine and boiler houses, &c.

One of the principal features of the bath is the arrangement, which has been patented, of warm lavatories having dual dressing rooms, in lieu of the ordinary slipper baths, these lavatories being combined with the swimming bath in such a manner that the bather having performed his ablutions and vacated the washing bath can still retain the use of his dressing room if so disposed, and enjoy the luxury of a swim.

The washing bath before referred to consists of a small bath, of enamelled iron, about 4 feet long and 12 inches deep, fitted with hot and cold water supply. The bath room is maintained at a temperature of 110 degrees by means of steam coils placed underneath the bath top, and over the centre of the bath a shower is placed, the temperature of which can be regulated by the bather, enabling him to thereby close the pores of his skin should he not be disposed to make use of the swimming bath. By the arrangement of dual dressing rooms the bath itself is not detained by the bather during the time he is dressing.

The swimming bath is of larger dimensions than would be used in the remaining subsidiary baths, and although it is not large enough to meet the requirements of water polo and other aquatic sports, it will be fitted up as completely as its size will allow, with diving stages, gymnastic and other appliances, so as to enable beginners to practice the various exercises necessary to their becoming proficient in the games, provision for which it is proposed to make in the central establishment before referred to.

The heating of the bath water, &c., is carried out on the Rosher system, which provides for the constant circulation and aeration of the water, the temperature of which is maintained at 70 degrees. The whole of the heating, both of the water for swimming bath and warm lavatories and the warming of the building, is done by steam supplied by two Babcock and Wilcox water-tube boilers. The swimming baths will be available for use at all seasons of the year.

The walls throughout are faced internally with glazed bricks, and the floors paved with marble concrete mosaic.

The contractors for the work are Messrs. Symonds & Co., of Cardiff, and the hot water engineering work is being carried out by the patentees of the system adopted, Messrs. The Rainbow Engineering Company, of London.

The total cost as per contract is 12,360*l.*

ROATH PARK.

This park is of very recent construction. Until six years ago the valley in which the park lies consisted of rough pasture and bog land, through which there was not even an occupation road or public footpath, and the marvellous change which has taken place in so short a time is almost inconceivable.

The total area of the park, including the outer roads, is 120 acres. The greater portion of the land was presented to the town by the Marquis of Bute, while smaller portions which intervened and were requisite to complete the scheme were readily given by Lord Tredegar and by Messrs. Clark and Jackson.

The ceremony of cutting the first sod was performed by the Marchioness of Bute on August 24, 1887, but it was not until July 1889 that actual work was taken in hand by the commencement of the first contract, let to Messrs. Logan and Hemingway, for the construction of the roads surrounding the two lower sections of the park.

This portion of the work was shortly afterwards followed by the chief contract, let to Mr. James Allen, of Cardiff, and which included the construction of the lake, which has a water surface of 32 acres, and the roads surrounding the botanical gardens, lake, wild garden, oval, &c.

The formation of the footpaths and the forming, levelling and laying out, and the planting of the grounds has been done by the Corporation day men, under the able superintendence of the head gardener, Mr. Pettigrew.

The land upon which the park has been formed is situated in the bottom of a valley through which runs a beautifully pellucid and winding brook, providing a splendid supply of water for the lake, and has otherwise been made the most of in laying out the grounds.

The brook inside the fences of the park is spanned by five iron footbridges, for which Messrs. Lysaght, of Bristol, were the contractors, the brick abutments being erected by Corporation day men. One wooden rustic bridge has also been erected across the brook in the pleasure gardens, the contractors for which were Messrs. E. Turner & Sons, of Cardiff.

A propagating house has been erected in the nursery for the raising of flowers and plants for bedding out.

The park is divided into 6 sections.

1. The recreation grounds, comprising an area of 23 acres.
2. The pleasure gardens, of 11 acres.
3. The botanical gardens, 15 acres in extent.
4. The lake section, 41 acres.
5. The wild garden, now in course of being laid out, 8 acres, and
6. The oval, yet to be formed and laid out, 2 acres.

The remainder of the area making up the 120 acres is taken up by the roads encircling the park, and which consist of 3⅔ miles of roads 40 feet wide, and ½ mile of roads 30 feet wide, and the construction of which necessitated the erection of six bridges spanning the brook.

The total length of the land occupied by the park from the lower end of the recreation ground to the oval is 1¾ mile, while a complete circuit of the roads compassing the two extreme sections forms a drive of 4 miles.

For enclosing the park, 4¼ miles of unclimbable iron fencing

6 feet high has been erected, and 4½ miles of post and wire fencing has to be provided for fencing off the adjoining lands.

In making the excavation for forming the roadways encircling the park, extending along the eastern road from opposite the lake embankment southwards, past a portion of the botanical gardens, a very fine section of the Silurian stratification was cut through, said by geologists of repute to be the finest exposed section in Great Britain. This is still open to view.

One of the chief features of the park is the lake, which is ½ mile in length, and, as previously stated, has a water surface of 32 acres.

The lake has been formed by constructing a dam across the valley, the length of which is 600 feet, and the greatest height from the old ground level 21 feet; the greatest depth of water is about 15 feet.

The by-wash is 20 feet in width, the walls of which are built of blue Pennant stone and coped with grey Cornish granite, the floor being formed of cement concrete and grey Cornish granite steps. The overflow sill of the lake is bull-nosed, of grey Cornish granite, and is 43 feet in length.

The upper portion of the lake has been formed by excavating to a uniform depth of 2 feet 6 inches below top-water level, and in this part several islands have been thrown up and planted with trees and shrubs, to provide protection for wild fowl and add beauty to the surroundings.

Boats are provided for those who delight in rowing, and the lake has been stocked with Loch Leven trout, and next season angling will be permitted.

The park was opened to the public on the 20th of June last, the ceremony being performed by the heir to the Marquis of Bute, the young Earl of Dumfries, on his thirteenth birthday.

Although much has been done to provide a park supplying all requisites for the enjoyment of the public, other works are required to complete the undertaking, such as public conveniences, band stands, shelters, refreshment pavilion, head gardener's residence, &c., and these works are now being taken in hand.

The total expenditure on the park up to the present has been 50,410*l.*, and when completed it is estimated to cost 55,000*l.*

OTHER OPEN SPACES.

In addition to the Roath Park, the Corporation have acquired the Ely Common, where they are now laying out a park 25 acres in extent, and another similar park on Canton Common, having an area of 22 acres. They have also during the past five or six years acquired fourteen open spaces, varying in area from ½ acre to 3 acres each.

DISCUSSION.

Mr. R. GODFREY: On the first visit of this Association to South Wales I think we may congratulate ourselves upon having received a most valuable and instructive paper from Mr. Harpur, the borough engineer. I beg most heartily to move a vote of thanks to Mr. Harpur for the paper he has prepared, and for the splendid exhibit of plans we have around us.

Mr. A. T. DAVIS: I have much pleasure in seconding the vote of thanks, and in doing so I should like to ask Mr. Harpur if he would be good enough to get the paper printed and distributed among those Members who are present here to-day, because it would be very useful if we could have the paper at our own homes to digest at our leisure.

The PRESIDENT: I assure you it comes as no surprise to myself that we have had so valuable and instructive a paper presented to us to-day. I know something of Mr. Harpur's work, and I know something of his father's work; and I knew very well if we came to Cardiff we should have very valuable information presented to us. The details given of the various public works are very exhaustive. I am sure to an Association like ours the information presented in the form we have had it given to-day must be very valuable to the Members who have attended, and to the municipalities which they represent. All the details of the works described are given with great fulness and clearness; and those works are fully up to date in every respect. Mr. Harpur has introduced every improvement that could possibly be devised; I know of nothing better than the improvements he has introduced. I might mention, for instance, that little point of dispensing with fillets in the angles of the rooms so as to avoid dust. That may seem a small matter, but it is most essential. You know very well that the germs of cholera or the other seven infectious diseases are spread not only miles but thousands of miles, The dust germ, like the pollen of the thistle, may be carried for many miles, and no man knows where it may fall, and produce misery and sickness and death. The information given to us in the paper shows that wherever the Members of this Association may meet it is possible to obtain information of the utmost value, not only to ourselves but to the great corporations which we have the honour to serve. It is not for ourselves alone that we collect this information but for the municipalities we serve. Many corporations are beginning to see and to recognise the value of our meetings, and I may here mention that the Mayor of Cardiff has appreciated it in the very highest and fullest sense. His worship proposes that the municipal engineers should attend the meetings of the Association of Municipal Corporations, together with the Mayors and Town Clerks of the various towns. You know the legal controversy which has arisen respecting the definition of "sewer" and drain, and the expense to which many corporations are being put in repairing what are actually private drains. The municipal engineer in attending the meetings of the Association of Municipal Corporations, would give them the advantage of his practical experience and assistance in this and other municipal engineering questions. I have very great pleasure in putting to you the vote of thanks to Mr. Harpur. I do not think it has ever been my privilege to listen to a paper which gave a great mass of detailed information with more clearness or lucidity.

The vote of thanks was accorded with acclamation.

Mr. Harpur in replying, said: Mr. President and gentlemen, I have to thank you very much for the hearty vote of thanks which you have so readily accorded me for preparing this paper. I cannot but say it is a very great pleasure for me to have your presence here to-day. Although I am a busy man it has been a pleasure to me to prepare this paper, and if I had more time at my disposal I should have been pleased to give you a longer paper with more detail. However, I hope it will be appreciated, and I hope the works which we are to see will meet with your satisfaction. I also hope that we may before long have the annual meeting of the Association in Wales. I can only say it will be my object to bring about such a desirable event.

Mr. J. T. Eayrs: There is one duty we have to perform before leaving this room, that is, to accord a vote of thanks to the Mayor and Corporation of Cardiff—to the Mayor for his reception of us this morning, and to the Corporation for the use of the room in which we meet. I have very much pleasure in proposing a vote of thanks to the Mayor and Corporation. It is indeed a pleasure for me to come to Cardiff. I have not visited the town for twenty years, but since coming here I have had an opportunity of seeing the rapid strides Cardiff has made. I know of no town which has made the progress Cardiff has done; and while it has progressed in population it has necessarily progressed in sanitation. We look to seaports like Cardiff to protect us from the invasion of cholera or like diseases. There is one point upon which I feel very strongly, that is the question of the support which local authorities give to our Association. We are always received with the very greatest kindness by the corporations of the towns which we visit, and it has always been a pet scheme of mine that corporations should induce their engineers to attend our meetings in much larger numbers. During my presidency I had the pleasure of communicating with most of the local authorities in England, and it has resulted in nearly one hundred towns contributing towards the expenses of their engineers in attending our meetings. This augurs very well for the future, and I think, as this is the first visit of our Association to the Principality of Wales, that the Welsh local authorities should take a note of it and instruct their surveyors to attend our meetings. There is no doubt the cost to the municipality is amply repaid, because the information their engineers give and receive in coming into contact with each other is invaluable. There is no doubt it is a pleasure to the engineer to attend, but on the other hand the information he gains cannot be obtained in any other way. I want to impress this on the local authorities on the occasion of our first visit to Wales.

Mr. HALL: I have very much pleasure in seconding the vote of thanks to the Mayor and Corporation of Cardiff for their kindness in granting us the use of these rooms. I have been very much pleased by my visit here because Mr. Harpur has shown us what I think is the right thing. Cardiff is one of the very few towns which make their borough engineer their engineer for every work. Allow me to congratulate Mr. Harpur upon taking his proper place.

The vote of thanks was unanimously accorded.

The Members attending the meeting were entertained to luncheon in the Assembly Room of the Town Hall, by the Mayor (Alderman P. W. Carey). The Mayor presided, and was *supported by the President (Mr. A. M. Fowler), the Members attending the meeting, the Members of the Corporation, and many of the leading citizens of Cardiff.*

A visit was then paid to Cardiff Castle, the residence of the Marquis of Bute, with its unique decorations by Mr. Burgess, and its palatial suite of modern apartments. Sir William Lewis placed a special train at the disposal of the Members, in which a tour was made of the magnificent series of docks, which have been constructed in recent years, to cope with the rapidly growing trade of the port. Captain Pomeroy acted as guide to the party, pointing out the principal points of interest, such as the length of quays, the lock by which the Roath dock is approached, and the Hunter-Lewis crane, by which steam-coalers are loaded with over 9000 *tons of coal in twenty-eight hours.*

At the conclusion of the visit, the President thanked Captain Pomeroy for his kindness in accompanying the party over the docks and explaining the points of interest; and also asked him to convey the thanks of the Association to the Marquis of Bute and to Sir William Lewis for their kindness.

A second party visited the new Sanatorium, which was having the finishing touches put to it, the Corporation Electric Light Station, the Clarence Bridge and the Guildford Crescent Baths, which were in course of construction.

On the conclusion of the visits, the Members met together at the Town Hall, where they were entertained to tea by Mr. Harpur. On the conclusion of an excellent repast, Mr. J. T. Eayrs (West Bromwich) thanked Mr. Harpur for his hospitality and for the admirable and interesting programme which he had arranged.

Mr. Harpur briefly acknowledged the compliment paid to him.

DISTRICT MEETING AT PLYMOUTH.

May 17 and 18, 1895.

Held in the Council Chamber, Municipal Buildings, Plymouth.

A. M. Fowler, President, *in the Chair.*

The Mayor of Plymouth (Mr. W. Law J.P.) opened the proceedings by extending to the Members and visitors a most cordial and hearty welcome to Plymouth. He referred to the marked progress which the town was making, and felt confident that the Members would be interested with much that was gratifying and instructive.

The President expressed the great pleasure which it afforded the Members to visit an ancient town which defended the interests of inland towns so nobly as had Plymouth in the past, and thanked the Mayor for his very hearty welcome.

The following papers were read and discussed.

PLYMOUTH AND ITS MUNICIPAL WORKS.

By JAMES PATON, C.E., Borough Engineer
and Surveyor.

The author does not propose to deal at any length with the history of Plymouth, as the limited scope of this paper will not permit of justice being done to such an important and highly interesting subject. According to Worth, the general history of Plymouth may be divided into three sections: "(*a*) Prehistoric and legendary, extending down to the compilation of 'Domesday'; (*b*) uncertain and fragmentary, dating from Domesday down to the incorporation of the borough by Act of Parliament in 1439; and (*c*) consecutive from 1439 onward to the present time." It is certain that from about the year 1540 to the present time, a period of over 3½ centuries, the borough has grown from a small fishing town into one of the most important ports in England and a busy commercial centre. The municipal history of Plymouth is of great interest, from the fact that it is the first borough in England to be incorporated by statute. According to Clifford's 'History of Private Bill Legislation,' "it was not until 1439 that a municipality was incorporated. Before that year neither in the Saxon charters nor in those granted under Norman rule, is there a trace of any municipal corporation. As such a body could only then be created by royal prerogative, the numerous charters granted to their boroughs by the great barons were, of course, silent on this subject. But the crown, in its early grants, did no more than the barons did: it bestowed rights and privileges on the burgesses for the time being. There was no specific incorporation in the modern sense, with power to hold lands by perpetual succession, have a common seal, and sue and be sued in the corporate name. Kingston-upon-Hull is generally mentioned as the first town thus favoured. Probably it owed this much-coveted boon to the dynastic quarrels of the period, and a wish by Henry VI. to secure in his interest a place of great strength, commanding the waterway into Yorkshire and other counties. But Hull was incorporated by charter as an act of royal grace; Plymouth, in the same year, was incorporated by statute, and is a more interesting, as well as an earlier example, for its claims to this new municipal status were considered by Parliament in the year 1411."

Site and Soil.

The borough of Plymouth is situate in latitude 50° 22′ N., longitude 4° 10′ W., and occupies the southern slope of the foot of the Dartmoor hills. The town stands upon the slate and limestone of the middle Devonian series, and rises to an average height of 100 feet above mean sea level.

General Statistics.

The area of the borough is 1497 acres (including Drake's Island). Of this area about 260 acres represents water area and land not available for building purposes, such as Government establishments, parks, &c. The population, according to the Census returns from 1821, is as follows: 1821, 21,591; 1831, 31,080—increase, 9489; 1841, 35,627—increase, 4547; 1851, 52,221—increase, 16,594; 1861, 62,599—increase, 10,378; 1871, 68,758—increase, 6159; 1881, 73,794—increase, 5036; 1891, 84,248—increase, 10,454; 1895, 89,096 (according to Registrar-General's returns). New dwelling-houses erected in 1889, 120; 1890, 142; 1891, 247; 1892, 143; 1893, 196; 1894, 181; 1895, 153. The estimated number of houses at the present time is 10,979. The density of population for the whole borough in 1891, 59 persons per acre, which is equal to 8·74 persons per house. These figures vary considerably, according to the character of the locality. In St. Andrew's parish the density of population equals 80·67 persons per acre, which is equal to 9·55 persons per house; in Charles parish the density of population is 37·85 persons per acre, which equals 7·87 persons per house.

RATEABLE VALUE OF THE BOROUGH.

In 1889-90, 280,618*l.*; 1890-91, 289,381*l.*; 1891-92, 297,657*l.*; 1892-93, 300,660*l.*; 1893-94, 309,791*l.*; 1894-95, 315,300*l.* Total rates for all local government purposes for the financial year 1894-95 is 6*s.* 5*d.* in the pound. Loan debt of the borough, 335,912*l.* The following figures represent the amount which 1*d.* in the pound produced in the undermentioned years—viz. 1889-90, 1111*l.*; 1890-91, 1137*l.*; 1891-92, 1178*l.*; 1892-93, 1207*l.*; 1893-94, 1225*l.*

STREETS AND ROADS.

Length of streets and roads repairable by the inhabitants at large, 36 miles 3 furlongs; length of back streets and lanes repairable by the inhabitants at large, 10 miles 2 furlongs—total, 46 miles 5 furlongs. The character of the formation of these streets, roads and lanes is classified as follows: macadamised, 25 miles 5 furlongs; granite sett paving, 7 miles 2 furlongs; wood paving, 3 miles 1 furlong; Staddon pitching, 10 miles 5 furlongs—total, 46 miles 5 furlongs. Length of unadopted streets and roads, 7 miles 6 furlongs; length of unadopted back streets and lanes, 3 miles 5 furlongs—total, 11 miles 3 furlongs. During the past 10 years the following private streets, roads and lanes have been sewered and completed under Section 150 of the Public Health Act, 1875; 65 streets, of a length of 6 miles 6 furlongs, at a cost of 19,375*l.* 4*s.* 2*d.*; 66 back streets of a length of 3 miles 7·50 furlongs, at a cost of 9171*l.* 8*s.* 9*d.* The footways of the streets are flagged with various kinds of material, including limestone, granite, and Caithness flagging, Coverack concrete slabs, Limmer asphalt, and tar paving. The expenditure on highways for the year ending March 31, 1895, was 6508*l.* 12*s.*; for street watering and cleansing, 6327*l.* 0*s.* 6*d.*; for sewers, 973*l.* 0*s.* 11*d.*; for street lighting, 4664*l.* 7*s.* 7*d.*

Cost of Materials Used in Road-making.

Road metal—Elvan stone, unbroken, 3*s.* 5*d.* and 3*s.* 10*d.* per ton; broken to pass through 2-inch ring, 5*s.* and 5*s.* 5*d.* per ton. Limestone for tar paving, 3*s.* per ton. First class granite setts, 3 inches by 6 inches by 6 inches to 8 inches long, 1*l.* 2*s.* per ton; ditto, 3 inches to 5 inches by 6 inches to 8 inches long, 1*l.* 3*s.* per ton; second class ditto, 3 inches to 4 inches wide, 6 inches deep, 9 inches long, 18*s.* 9*d.* per ton. Granite flagging, 10*s.* per super yard; 12 inches by 8 inches bevelled granite kerb, 1*s.* 2*d.* per lineal foot; 12 inches by 8 inches bevelled granite kerb, circular on plan, 1*s.* 5*d.* per lineal foot; 12 inches by 6 inches granite channel blocks, 1*s.* per lineal foot; 12 inches by 6 inches granite channel blocks, circular on plan, 1*s.* 3*d.* per lineal foot; 15 inches by 8 inches granite channel blocks, 1*s.* 5*d.* per lineal foot; 15 inches by 8 inches granite channel blocks, circular on plan, 2½ to 2¾ inches thick, 1*s.* 9*d.* per lineal foot. Caithness flagging, laid complete, 6*s.* per super yard. Coverack concrete slabs, 2 inches thick, laid complete, 6*s.* 3*d.* per super yard. Limestone flagging, laid complete, 9*s.* 6*d.* per super yard.

Wood Paving.

Wood block paving has been used in Plymouth to a considerable extent for the carriage-ways of the leading thoroughfares in the centre of the town. The first wood paving laid in Plymouth was during 1879, when a small experimental piece was laid at the top of George Street, where the whole of the traffic is concentrated within a width of practically two vehicles, on a gradient of 1 in 20, and a second piece in Bedford Street at its narrowest part. The piece in George Street was renewed in 1886, making the life of the paving seven years; the cost of construction and renewal was

19*s.* 4*d.* per yard for a life of 14 years. The piece in Bedford Street was renewed in 1889, making the life of the paving 9½ years; the cost of construction and renewal being 18*s.* 4*d.* per yard for a life of 17½ years. These samples were laid by the Improved Wood Paving Company, but were renewed by local contractors. A further area of wood paving was laid down in 1881 by the Improved Wood Paving Company in Bedford Street and Old Town Street, extending from Catherine Street to Treville Street. This paving, particularly in Old Town Street, is very irregular on the surface, the blocks being worn in places to 1¾ inch in depth, the original depth of the block being 5 inches. The timber used in the above mentioned instances was red deal dipped in creosote. The blocks used in subsequent works were 7 inches by 3 by 5 inches deep white Baltic, saturated with creosote oil equal to 10 lbs. per cubic foot. The paving is laid on a solid bed of Portland cement concrete 6 inches thick, the surface being floated over with fine stuff to form a uniform and smooth surface. The blocks are laid hard upon the concrete, in courses at right angles to the line of traffic, with ¼ inch joints. The joints have been treated in two ways: first by running an asphaltic mixture into them for about 1 inch in depth, and then filling up the remaining space with cement grout; and second, by running in sufficient grout to secure and steady the blocks, then racking the joints with limestone gravel and grouting with asphaltic mixture. Sufficient time is allowed for the cement foundation to harden before the blocks are laid down, and where the joints are grouted with cement a period of seven days should elapse before the traffic is allowed to pass over the paving. One of the advantages of asphaltic grouting over cement grouting is that the traffic can be passed over the wood paving immediately after completion. The following streets have been wood paved beyond those already named: Old Town Street, from Treville Street to Ebrington Street, in 1883; Bedford Street and Bank Street, in 1884; Flora Street, in 1885; Saltash Street, Exeter Street (part of), in 1886; Exeter Street, from Green Street to Moon Street, in 1888; Whimple Street, Cornwall Street, from Bank Street to market entrance, and Jubilee Street, in 1891; Union Street, in 1892; Westwell Street, in 1893; and King Street, Frankfort Street, Cornwall Street from Russell Street to Bank Street, Market Avenue, Drake Street (work now in hand), in 1894. The wood paving of King Street, Frankfort Street, Cornwall Street and Market Avenue was carried out under the supervision of the author, the work being executed by Corporation workmen. The details of the cost are given, as they may be of interest:—

Frankfort Street.

Wages, including labour for all purposes, 1*s.* 6½*d.* per yard super; wood blocks, delivered on site, 5*s.* 2*d.*; concrete foundation, including floated surface in place only, 2*s.* 3*d.*; pitch and cement grouting (materials in place only), 8*d.*; cartage of excavated material, 5½*d.*—total cost per yard super, 10*s.* 1*d.*

Cornwall Street and Market Arcade.

Wages (inclusive of all labour), 1*s.* 10½*d.* per yard super; wood blocks (delivered on site), 5*s.* 2*d.*; concrete foundation (including floated surface (materials in place only), 2*s.* 3*d.*; grouting with asphaltic mixture and racking with gravel, 9½*d.*; cartage of excavated material, 5*d.*—total cost per yard super, 10*s.* 6*d.*

From the experience gained in Plymouth, the life of soft-wood paving may be taken as varying from 10 to 12 years, according to the width of the street and character of the traffic. In repaving Old Town Street, Bedford Street, Ebrington Street and Ham Street, the author has recommended the use of hard wood, and the Works Committee has favourably considered the recommendation, subject to inquiries being satisfactory as to hard wood not being more slippery than soft wood.

SEWERAGE.

The sewerage of the borough has received the constant and careful consideration of the Council for some years past, and presents the most difficult problem in connection with the sanitary administration of the town. On December 22, 1887, Mr. Baldwin Latham, C.E., reported to the Corporation on the sewerage of Plymouth. This report dealt exhaustively with the difficulties of the question, and recommended the carrying out of certain works to prevent flooding in the low-level districts of the town, and the improvement of the outfalls by the construction of new intercepting sewers, at an estimated cost of 24,000*l.* In March 1890, Mr. G. D. Bellamy, then borough engineer and surveyor, reported on this important question, and placed before the Council a scheme which was approved. The objects of Mr. Bellamy's scheme were: (1) the

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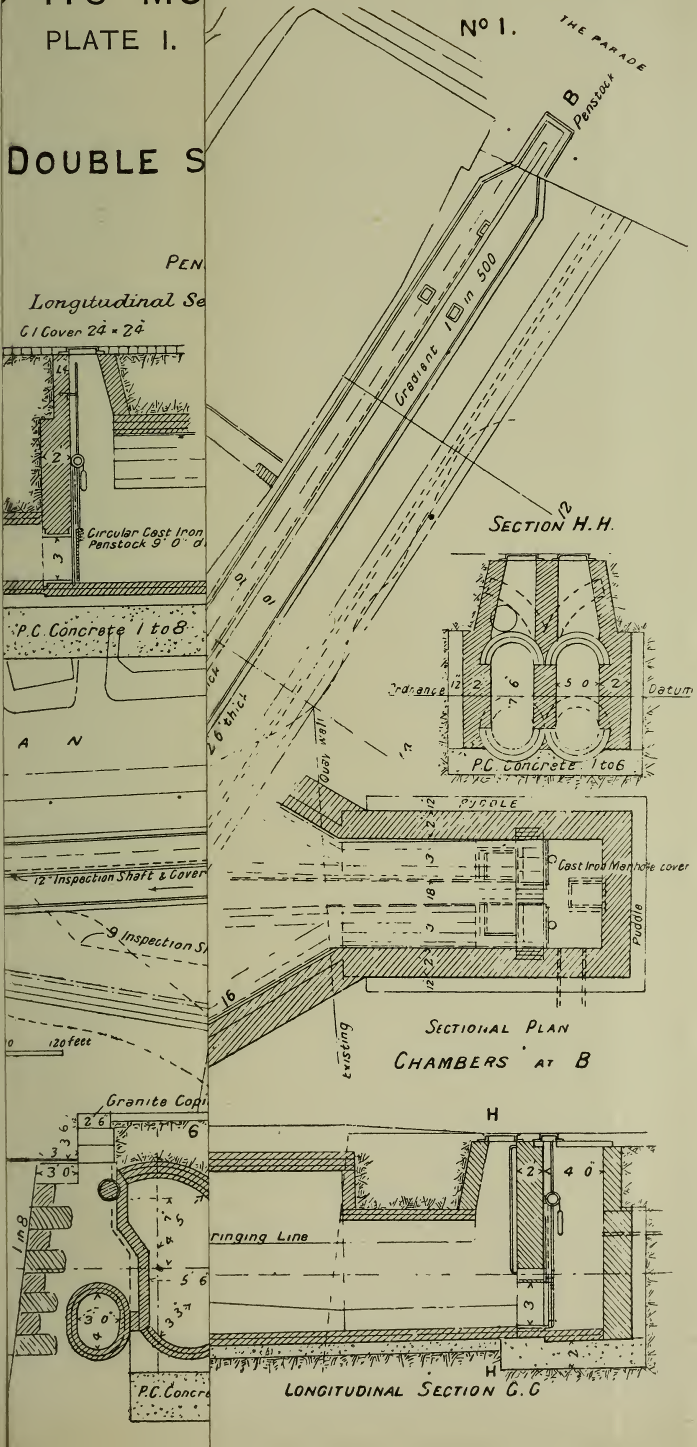
PLATE I.

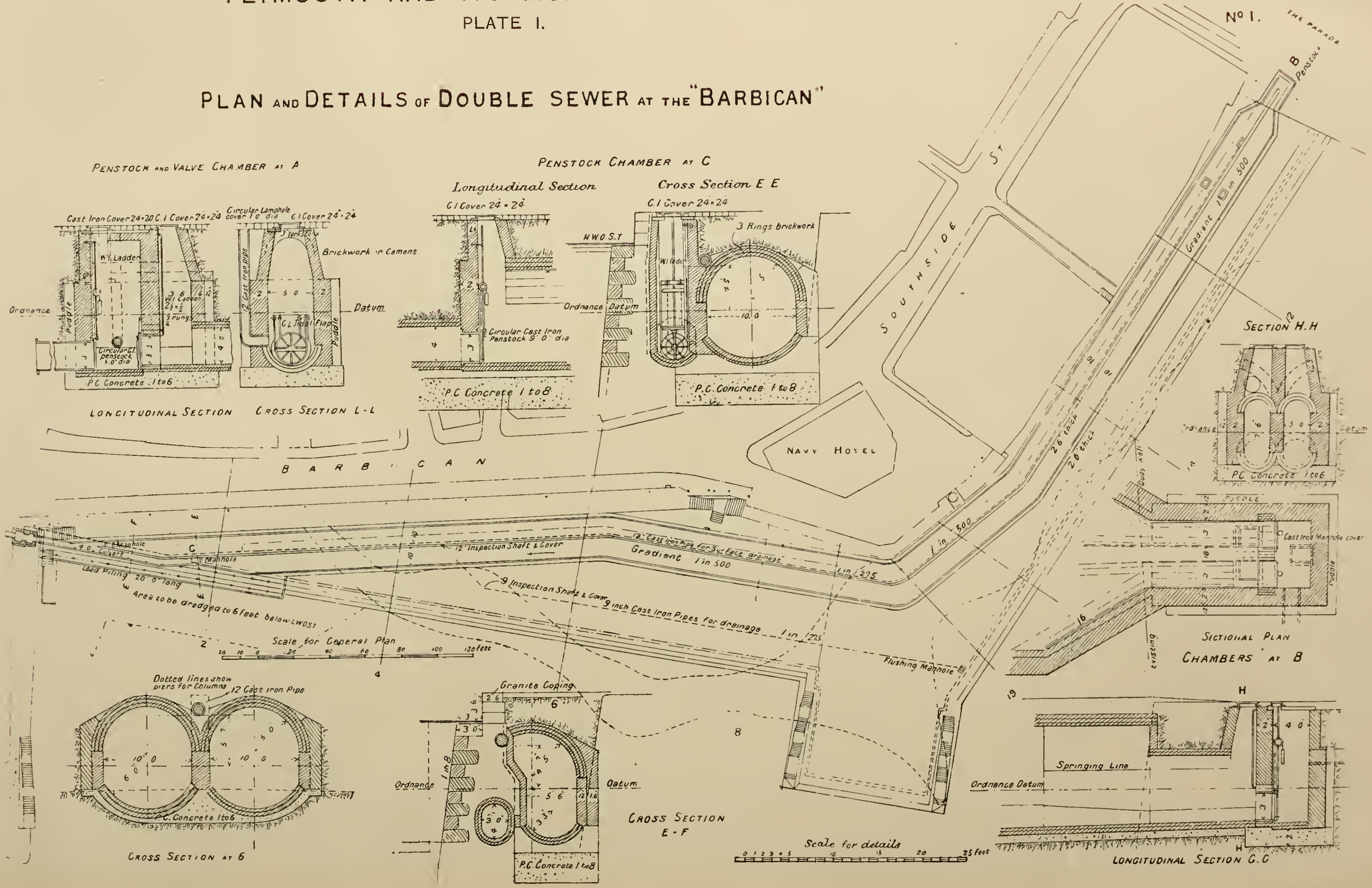
DOUBLE S



PLYMOUTH AND ITS MUNICIPAL WORKS.

PLATE I.

PLAN AND DETAILS OF DOUBLE SEWER AT THE "BARBICAN"



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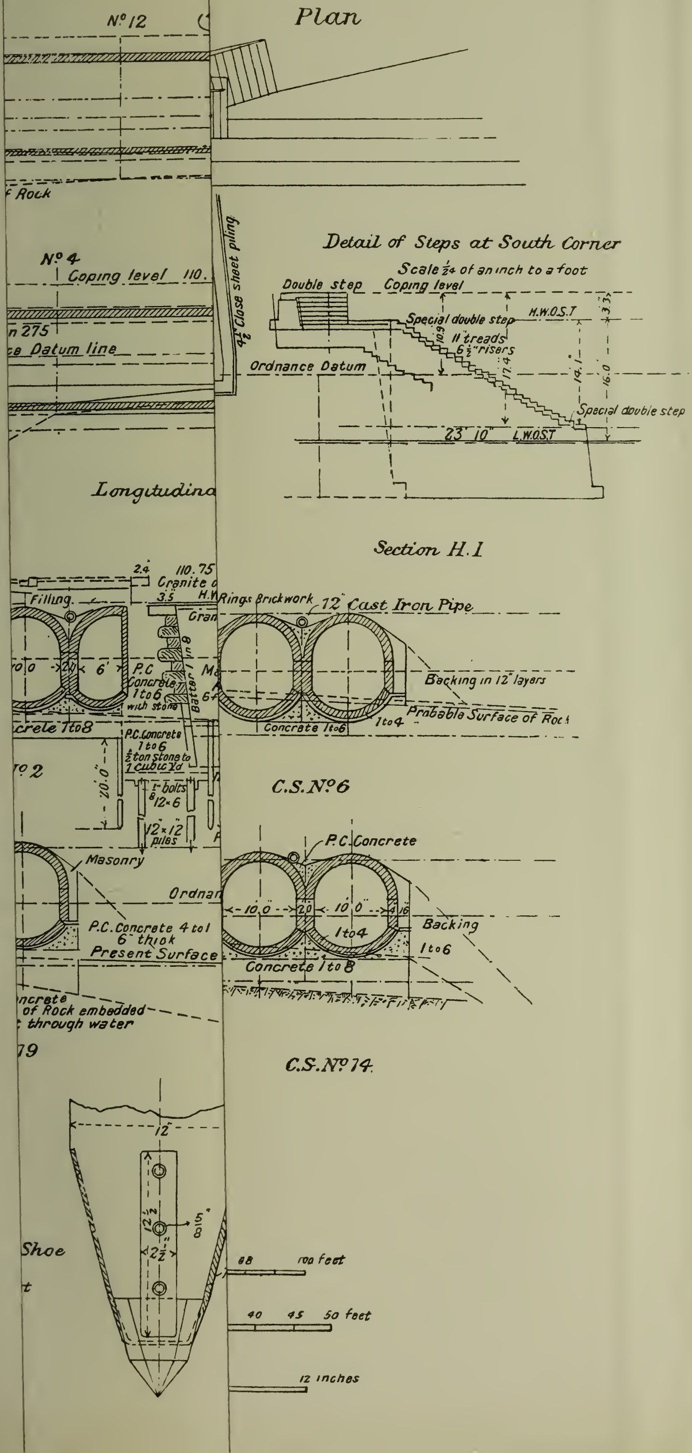
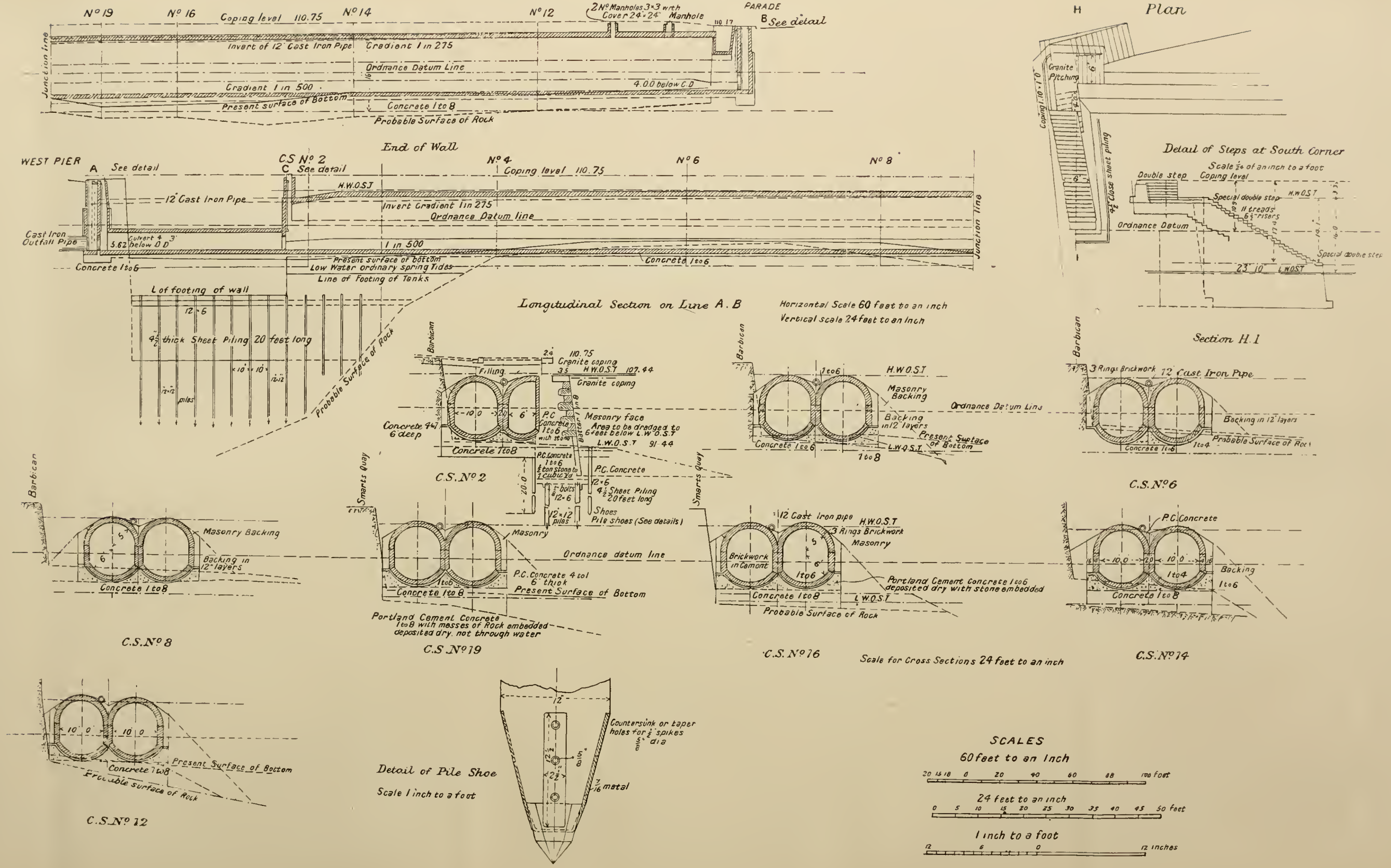


PLAN AND DETAILS OF DOUBLE SEWER AT THE "BARBICAN"—*continued.*



discharge of as much as possible of the sewage southward of the citadel into the strongest tidal current; (2) to diminish to the smallest practicable extent the passage of high-level sewage through the low-level sewers to prevent the flooding of the low-level districts; (3) to minimise the discharge of sewage into the Cattewater. Part of Mr. Bellamy's scheme is being carried out in accordance with his designs, and under his supervision, at a cost of 30,000*l*. In October 1894, Mr. James Mansergh, C.E., was called in to advise the Corporation before any further expenditure was incurred, and Mr. Mansergh's report and scheme was unanimously adopted by the Council. The estimated cost of carrying out this scheme is 100,000*l*. Under the present arrangement, the borough is divided into six drainage areas: the eastern district comprises an area of 350 acres, with an outfall into Deadman's Bay; the western district, comprising an area of 272 acres (including 28 acres of Stonehouse), with an outfall into the Sound near the Great Western Docks; the southern district, comprising an area of 47 acres, with an outfall near Fisher's Nose; the north-eastern district, comprising an area of 197 acres, with an outfall through the sewers of the Compton Gifford District Council into the Laira at Arnold's Point; the north-western district, comprising an area of 71 acres of the borough and 143 acres of Compton Gifford, with an outfall through the Stonehouse and Devonport joint intercepting sewer, with an outfall at Eastern King; the West Hoe district, comprising an area of 18 acres, with an outfall into the Sound near West Hoe Terrace. The outfalls for all the districts are tidal. As might be expected in an old town, many of the old sewers are of an obsolete character, and the author is now preparing a scheme for the reconstruction of these subsidiary sewers.

Street Cleansing.

For the purposes of street cleansing, the borough is divided into one night district and three day districts. The night district comprises the main and business streets and the congested district in the centre of the town, about 11 miles of streets. The night gang consists of one foreman, nine men, and two horse-brooms. The men work from 12 midnight to 10 a.m., taking one hour for breakfast. The streets in this district are thoroughly cleansed every night, and, in addition to the night gang, 19 men are employed during the day from 8 a.m. to 6 p.m. The three day districts are cleansed by two parties of five men each, and one of four men, working from 6 a.m. to 5 p.m. The two former are divided into three sections each, which are worked in turns daily, thus each section is cleansed twice during the week. The latter district is divided into two sections, each being taken on alternate days. Seven additional men are employed on these districts individually, cleaning such portions as are not cleaned by the parties.

COST OF WATERING AND CLEANING THE SEVERAL CLASSES OF ROADS PER SQUARE YARD PER ANNUM.

Class of Road.	Watering.	Cleaning.
	d.	*d.*
Wood paving	0·83	5·53
Macadam, first class	0·53	2·47
Stone paving, first class	0·27	1·80
Macadam, second class	0·27	1·26
Macadam, third class	0·13	0·99
Stone paving, second class	—	0·88

The street cleansing staff consists of one inspector, one clerk and foreman, two general foremen, four gangers, one storekeeper, one street-watering foreman, 49 sweepers.

HOUSING OF THE WORKING CLASSES.

Plymouth, like many other ancient boroughs, contains within its boundaries considerable areas of slum property, densely populated by members of the labouring classes. The question of dealing with unhealthy areas and houses unfit for human habitation is always a difficult one, and in Plymouth this difficulty is accentuated from the fact that the poorer classes have been accustomed for the past three centuries to crowd into tenements. Some idea of this overcrowding in the old part of the town may be gathered from the fact that the area of the borough originally enclosed by the old walls contained a population of 6000 persons in the year 1625: this area is now populated by about 20,000 persons. In the author's opinion the cause of the overcrowding is the excessive rental occasioned by the high price of land. On October 28, 1891, the medical officer of health (Dr. F. M. Williams) made a representation to the Sanitary Committee under the Housing of the Working Classes Act, 1890, that within the area bounded by Looe Street, Howe Street, Buckwell Street, and Vauxhall Street were houses, courts and alleys, the narrowness, closeness and bad arrangement of which, together with the want of sufficient light, air and ventilation, were dangerous and injurious to the health of the inhabitants of the buildings in the said area, and the committee resolved to forthwith prepare a scheme for improving the same. A scheme was submitted to and approved by the Sanitary Committee on September 29, 1892, which was, shortly, as follows: (1) land and houses within the limits of the area to be taken and purchased compulsorily under the provisions of the Act; (2) all the houses within the limits of the area to be pulled down and the sites cleared; (3) the whole of the area to be utilised in part for laying out improved streets and approaches and in part for the erection of dwelling-houses for the working classes with suitable air spaces and conveniences; (4) the displaced population to be provided with suitable dwelling-houses, either temporarily or permanently, as may be found necessary, on land to be purchased at Prince Rock. The number of houses in the condemned area is 63, with a population of 813, or 12·90 persons per house. A provisional order confirming the scheme was confirmed by an Act on June 29, 1893. Twenty-nine acres and two roods of land have been purchased at Prince Rock to provide for the displaced population of the condemned area, and for the population disturbed by the widening of Ebrington Street, Ham Street and Southside Street, and for other town purposes. The area proposed to be dealt with immediately is nine acres three roods, the remainder being as yet unappropriated. Competitive designs were invited for the erection of dwelling-houses on the condemned area and on land at Prince Rock. Mr. Charles Berry, architect, was appointed assessor on the competitive plans, and he awarded premiums in the order shown in Tables A and B.

The cost of the land purchased at Prince Rock was 19,097*l.* and the Corporation now contemplates expending 23,400*l.* in the erection of buildings and laying out of new streets to provide for the displaced population in Howe Street and Looe Street. The houses to be taken in hand at an early date and erected as may be found necessary are as follows:—16 five-roomed houses, estimated rental 5*s.* 6*d.* per week; 16 four-roomed houses, estimated rental 4*s.* 6*d.* per week; 6 five-roomed flats, estimated rental 4*s.* per week; 40 four-roomed flats, estimated rental 3*s.* 6*d.* per week; 26 three-roomed flats, estimated rental 2*s.* 9*d.* per week—total, 412 rooms accommodating 824 persons. Messrs. Hine and Odgers estimate that the revenue based upon the rentals mentioned will be equal to 4$\frac{5}{8}$ per cent. upon the capital expenditure. The author

TABLE A.—PRINCE ROCK SCHEME.

1. Hine and Odgers, Plymouth. 2. King and Lister, Plymouth. 3. C. S. Webbe, 101 Cannon Street, City.

Order of design.	Number of dwellings.	Author's estimate for dwellings only.	Rate per cube foot on author's estimate for dwellings only.	Estimate at 6*d.* per foot cube.	Number of rooms including sculleries.	Number of persons accommodated at two persons per room.	Rate per person on author's estimate.
1	233	£32,107	3½*d.*	£55,190	852	1,704	£18 17*s.*
2	235, 10 shops and industrial block.	£55,009	About 4½*d.*	£83,304	1,227	2,454	£22 8*s.*
3	302 dwellings, 15 shops, with five rooms each.	£68,118	7*d.*	£59,428	1,694	3,388	£20 2*s.*

TABLE B.—HOWE STREET AND LOOE STREET SCHEME.

1. Locke Worthington, 23 Queen Anne's Gate, Westminster. 2. Sanders and Lucas, High Street, Southampton. 3. J. A. Lucas, High Street, Exeter.

Order of design.	Author's cube.	For author's estimate.	Rate per foot cube on author's estimate.	Estimate at 6*d.* per foot cube.	Number of rooms exclusive of sculleries.	Number of persons accommodated at two persons per room.	Rate per person on author's estimate.
1	1,046,835	£26·170	6*d.*	£26,170	347 rooms, three shops, coffee tavern, six wash-houses, &c.	794	£32 19*s.*
2	898,453	£18·590	5*d.*	£22,461	359 rooms, 12 shops.	718	£25 17*s.*
3	888,808	£14·763	4*d.*	£22,145	324	648	£22 15*s.*

is now proceeding with the construction of the sewers and the formation of the new roads at Prince Rock, and no doubt building operations will be commenced this year.

TRAMWAYS.

The tramways undertakings in Plymouth were originally in the hands of two companies—viz. the Plymouth Tramways Company, and the Plymouth, Stonehouse and Devonport Company. In 1892 the Corporation was impressed with the desirability of acquiring the tramways of the first-mentioned company for the benefit of the borough on the following grounds. The removal of a very great public inconvenience, which had been caused by the manner in which the company had executed its work and conducted its business; the policy of the Legislature is to facilitate the acquisition of tramways by local authorities, thus avoiding friction and difficulty arising from the division of authority in the matter of street repairs; the management of the tramways by the local authority would ensure greater facilities to the general public, and materially assist the development of the outlying districts of the borough. After a considerable amount of negotiation the undertaking was purchased by the Corporation under the powers of the Plymouth Tramways Act, 1892, for 12,500*l.*, the length of lines being 3·5 miles. On November 15, 1892, the Council instructed the tramway sub-committee to take such steps as might be necessary to open for traffic the lines acquired by the Corporation. Acting on this authority the committee purchased six cars at 119*l.* per car. The committee also purchased from the old company six of their best cars—four at 80*l.*, and two at 35*l.* Two of these were altered and fitted with outside seats. Horses were also purchased, and other steps taken to carry on the traffic. The experience gained by the working of the tramways induced the Council to double the line from Sherwill Chapel to Compton, which work has been carried out to the great advantage of the public. The tram lines have a total length of 4 miles ·59 chains, made up as follows:—

	m.	f.	c.
Main line—Market Place to Compton Lane	1	5	0·81
Houndiscombe Road line	0	7	6·02
West Hoe line	1	1	5·55
Depot, Compton	0	1	5·39
Depot, West Hoe	0	0	2·82
	4	0	0·59

There are two depots, one at Compton and the other at Millbay Road.

Compton Depot.—The depot situate at Compton Lane was purchased from the Provincial Tramways Company for 3000*l.*, and contains an area of 62,000 square feet. Since the purchase additional stabling for 44 horses, car sheds capable of holding 20 cars, workshops, blacksmiths' shops, foreman's house, stores, &c., have been erected at a cost of 3396*l.* 15*s.* 2*d.*, and the site affords ample space for future extensions. The stables will now accommodate 81 horses.

Millbay Road Depot.—This depot contains an area of 11,427 square feet, the land being purchased from Mrs. Ellen Booth for 1600*l.* The buildings were designed by and erected under the superintendence of Mr. G. D. Bellamy, M.Inst.C.E., consulting engineer to the Corporation, and consist of stabling for 15 horses, car shed, harness rooms, &c., the cost of buildings being 1101*l.*

Cars.—These are 17 in number, and cost 1797*l.* 10*s.* 9*d.* The particulars of the cars found most suitable for the Plymouth traffic are as follows: pair-horse tramway carriage, with garden seats on roof, seats inside for 16, seats on roof for 18—total, 34 passengers.

Dimensions of the Cars.—Length of body inside, 11 feet 4 inches; length of body including platforms, 18 feet 4 inches; extreme width, 6 feet; wheel base, 4 feet 10 inches; weight in complete running order, 39 cwt.

Horses, &c.—The horses number 96, and cost 3331*l.* 10*s.* Miscellaneous plant, including gas engine for manipulating fodder and other purposes, harness, stable implements, &c., has cost about 730*l.* The total capital expenditure is 41,903*l.* 8*s.* 6*d.* According to Mr. D. K. Clarke, C.E., the total capital expenditure in England and Wales, which includes expenditure on horses, cars and plant, is 14,800*l.* per mile of tramways open for traffic. Taking the mileage of the tramways belonging to the Plymouth Corporation at 4 miles, the total capital expenditure is 4325*l.* less per mile than the average in England and Wales. The working of the tramways by the Corporation has resulted in a loss, which amounted to 1150*l.* up to March 1894; this debit balance is now increased to 3265*l.*, the actual deficit on the last year's working being 1297*l.* The deficit on revenue account will, in the author's opinion, be entirely wiped out when the tramway system is completed and the Compton and West Hoe lines are connected. There

OUTH AND

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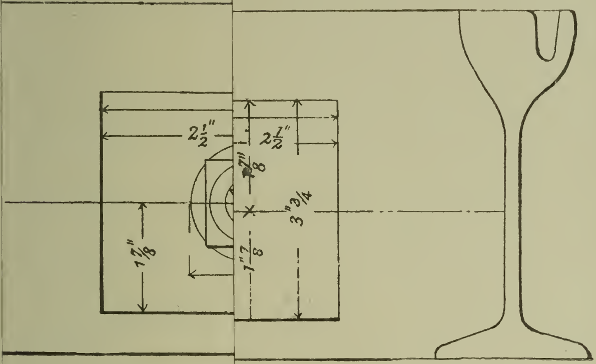

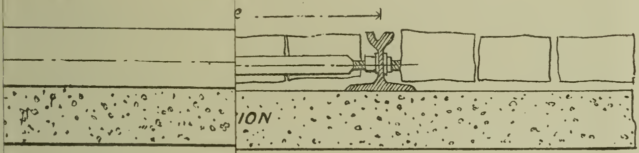

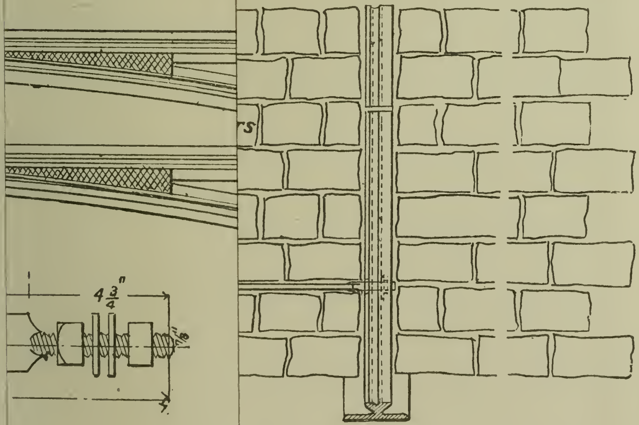

CORPORATION

PLYMOUTH AND ITS MUNICIPAL WORKS.

PLATE II.

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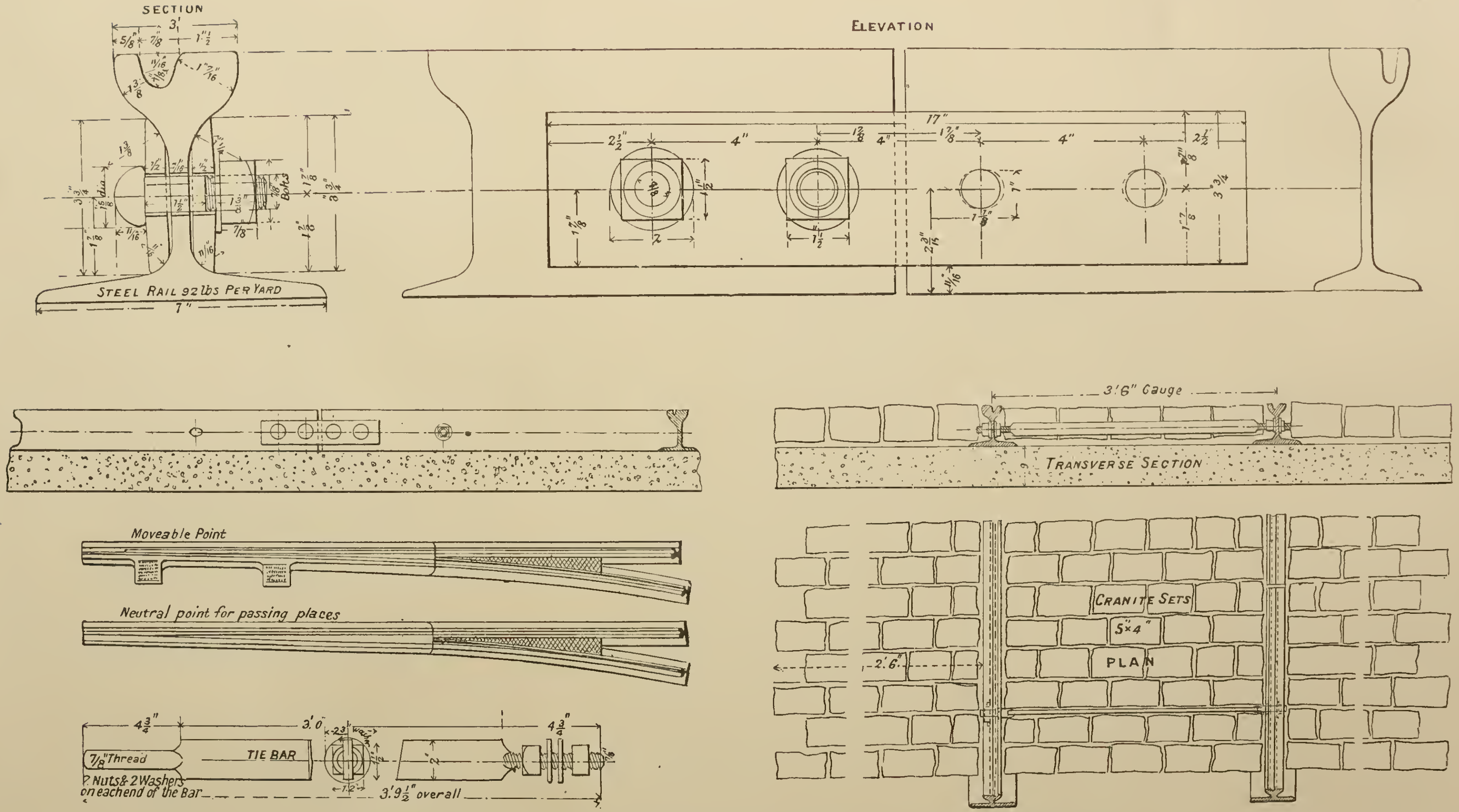

PLYMOUTH CORPORATION TRAMWAYS—DETAILS OF CONSTRUCTION.

is no reason why the undertaking should not be self-supporting and in time contribute towards the relief of the rates. The passengers carried for the year 1894 were 1,218,617, and for 1895, 1,423,130; fare, 1*d.* for any distance.

Construction of Lines.—The foundation of the track is formed with Portland cement concrete 6 inches in thickness. The concrete is composed of one part of best Portland cement to two parts of clean, washed sand and four parts of broken limestone, by measure. The rails are of best Bessemer steel, girder section 6 inches deep, weighing 92 lbs. per lineal yard. Standard length of rails 27 feet. Joints secured with fishplates of best Staffordshire bar iron; each plate is 1 foot 4 inches long, 3¾ inches wide, and ½ inch thick, punched with four round holes 4 inches apart. The tie-rods are of best Staffordshire iron, 1½ inch by ½ inch, with ¾ inch screwed ends for back and front nut. Rails fixed to a gauge of 3 feet 6 inches. The tramway track is paved with granite setts, 5 inches by 3 inches by 6 inches to 8 inches long; joints, ⅜ inch wide, racked with limestone gravel and grouted with an asphaltic mixture. The cost per mile of single line is 4200*l.*

Details of Cost.—Excavation, 12 inches deep, 9*d.* per super yard; cement concrete 6 inches thick, 2*s.* 3*d.* per super yard; sand, bedding 1 inch thick, 1*d.* per super yard; granite paving, including racking, 7*s.* per super yard; grouting with Portland cement (2 to 1), 5*d.* per super yard; grouting with asphaltic mixture, 9*d.* per super yard; steel girder rail, 6*l.* 15*s.* per ton; fishplates, 7*l.* 15*s.* per ton; bolts and nuts, 13*l.* per ton; steel points, 7*l.* 10*s.* per pair. The author has prepared plans for extending and connecting up the tramway system in the borough at an estimated cost of 12,000*l.*

PUBLIC PARKS AND PLEASURE GROUNDS.

Plymouth is well provided with parks and recreation grounds, the most important of which is the Hoe. The Hoe in the early history of Plymouth formed part of the "waste" of the manor of Sutton, and as such belonged to the Corporation, and one of the oldest rights connected with it is that of the fishermen to spread their nets on it for the purpose of drying them. Gradually, as the town developed, the Hoe became more appreciated as an open space, and the Corporation from time to time improved the approaches and provided shelters, seats, &c. As a marine promenade the Hoe is unequalled in England. The area of the Hoe to low-water mark of ordinary spring tide is 50 acres. The Beaumont Park area is 9 acres; Freedom Fields area is 8 acres; and the Lipson Pleasure Ground area is 5 acres. There are also two small pleasure grounds in connection with reservoirs at Drake's Place and at Hartley.

Street Improvements.

It is not until within recent years that the governing body carried out street improvement to any great extent. The appearance of some of the leading thoroughfares clearly shows that the widening of streets was carried out in a spasmodic way. In 1891 the Corporation obtained a provisional order for the widening of Ebrington Street and Ham Street. The improvement is now being carried out, and will probably be completed by the end of the year. The width of the streets when widened will be 40 feet. In 1892 a provisional order was obtained for the widening and improvement of Tavistock Road, Portland Place East, Higher Batter Street, Old Town Street, Southside Street, Regent Street, and Lipson Road, some of which have been completed, the remainder being in hand. A further provisional order was obtained in 1893 for the widening of King Street West, Regent Street, Kinterbury Street, Beaumont Road, Quay Lane, Mill Street, Longfield Place, Tavistock Road, Tavistock Place and Cambridge Street. Some idea of the comprehensive way in which town improvements are now dealt with will be gathered from the following return of the expenditure during the past 10 years: year ending March 25, 1886, 277*l.*; 1887, 7028*l.*; 1888, 9234*l.*; 1889, 14,753*l.*; 1890, 2996*l.*; 1891, 12,951*l.*; 1892, 21,502; 1893, 9404*l.*; 1894, 11,318*l.*; 1895, 50,815*l.*—total, 140,278*l.*

Public Buildings.

The public buildings, the property of the Corporation, include the following: Guildhall and Western Law Courts, Municipal Offices, Free Library (Old Guildhall), Theatre Royal, Royal Hotel, Borough Lunatic Asylum, markets, &c.

MARKETS.

The first grant to hold a market in Plymouth was about 1253. The site of the present market buildings was purchased about 1800, the foundation stone being laid in 1804. The market was opened in 1807, and the tolls were let by auction in 1809 for 900*l.*; in the following year the tolls made 2010*l.* In 1882 the Corporation accepted the design of Mr. C. King, architect, for the re-erection of the market buildings at an estimated cost of 35,000*l.* This scheme has been carried out in sections, and is not yet completed, part of the work being now in hand. The expenditure to which the Council is committed in re-erecting the markets is 43,546*l.* It is further contemplated the re-roofing of the poultry, vegetable and fish market at an estimated cost of 12,000*l.* The foregoing sketch can only deal very shortly with the development and progress of Plymouth; at the same time, it will give the Members of the Association some idea of the progressive spirit now actuating those responsible for the municipal government of the town.

THE WATER SUPPLY OF PLYMOUTH.

By EDWARD SANDEMAN, A.M.I.C.E., Water Engineer.

Unlike many of the large waterworks of this country, those of Plymouth have belonged to the town since their commencement. The first Act giving powers for the construction of works of water supply was passed as far back as the year 1585, in the reign of Queen Elizabeth. Under it the Corporation made a dam across the head waters of the river Meavy, and cut a watercourse, called locally a leat, from thence to the town. The Act, which is short and comprehensive, gave powers to the Corporation which in these days would be considered exceptional in character. It may be interesting to quote a portion of it. It is entitled:

"An Acte for Presvacon of the Haven of Plymowth.

Anno El.R. 27o No. 21 WHEREAS, yo^r^ Ma^ts^ Towne of Plymowth in the Cowntie of Devon being an auncyent Borough Towne bordering vpon the meane Sea, yet havinge a pleasaunte and safe Harboroughe and Rode for Shipps within or nere the same, comonlie called Plymmowth Haven, wheare as well yo^r^ Ma^ts^ Shippes as the Shipps and Vessells of dyvers yo^r^ Highnes Subiects tradinge into forren Partes and from Porte to Porte within this Realme do often vpon necessitie and otherwise arrive harboroughe refresshe and vittell themselfes as well w^th^ fresshe water, being a thing verey necessarie for them, as withe divers other thinges, Hathe, for the moste Parte of the yere, none, or at the leaste verey little, fresshe water within a myle of the saide Towne or thereabowt, a matter verey incomodiouse; By reason whereof yo^r^ Ma^ts^ Shippes and the Shippes of yo^r^ Highnes subiects arryveng and harbowring in the saide Haven as aforesaid The Maryners of the same are manye and often Tymes dryven by necessytie to goe a Myle or more from the saide Towne and theire Shippes to fetche fresshe water for theire necessarie vses, by reason whereof dyvers Tymes they loste dyvers good wyndes and oportuyties whiche they might take benefite of, yf they mighte water them selfes nere theire Shippes; besides the saide Towne being subiecte to fyer, as well by the Enemye, for the same was once burned by the ffrenche in the tyme of Warre, as by negligence and other mishappe at Home, there is no water in or nerer the saide Towne for the moste parte of the yere (especiallie in the Summer Tyme when the Daungers be greateste) then a Myle or sometyme more, as the dryeth is, and wheare also the saide Haven of Plymowth, being one of the pryncipall Havens and Harboroughes of the West Parts of Englande, dothe Daylie querre & fill wth the sande of the Tynne-woorcks and Mynes nere adioyneng to the same, and in shorte Tyme wilbe utterlie decayed, yf some Redresse and Speedie Remedie be not hadd; and wheare also there is a Water or Ryver within the saide Countie of Devon called the Water or Ryver of Mewe als Mevye, distante from the saide Towne abowte Eight or Tenne Myles, Parte of the whiche Water or Ryver wth some chardge wilbe brought into the saide Towne of Plymowth withowt any greate Preiudice or Damage to anye Owner or Owners of any Lande throughe whiche the same shalbe conveied, By reason (the moste Parte) in effecte all the same Lande is either barren and heathie or ells hillye and drye grounds whiche wilbe bettered and amended by the water that shallbe brought throughe the same. By bryngeng of whiche water most of the Incamodities and Daungers and divers others shall not onlie be remedied, but also some Parte of the Chanell of the saide Haven scowred and clensed by the same Ryver to the p^{r}petuall contynewunce of the same Haven, a matter moaste beneficiall to the Realme. And wheare also the Inhabitants of the same Towne are Incorporated by Kinge Henry the Sixte by the name of the Maio^{r} and Coialtie of Plymowth whiche is confirmed by yo^{r} Ma^{tie} and dyvers yo^{r} noble Progenito^{rs} Kings of this Realme May it therefore please yo^{r} moste Excellent Matie of yo^{r} moaste noble and aboundant Grace and accustomed ffavoure that yt maye be Inacted by this present Pliament that yt shalbe Lawfull to & for the saide Mayo^{r} and Coialtie and to theire Successo^{rs} at all Tymes after the ffeaste of Easter nowe next comynge, to digge and myne a Diche or Trenche conteynenge in Bredthe betwene sixe or seaven ffoote over in all Places throughe and over all the Lands and Grounds lyeng betweene the saide Towne of Plymowth and anye parte of the saide Ryver of Mewe als Mevye, and to digge, myne, breake, bancke and cast vpp, all and all maner of Rockes Stones Gravell Sande and all other Letts in anye places or Groundes for the convenyent or necessarie Conveyenge of the same River to the saide Towne, and further from Tyme to Tyme to doe Repacon and make Weares Bancks and all other Things necessarie whereby the saide River may be brought & contynewe vnto the saide Towne withowte Lett Denyall Vexacon or Trooble of the Lord or Lords Owner or Owners of the same Grounde, &c."

It will be seen that one of the reasons urged for the making of the watercourse was the good effect it would have in scouring the harbour and in preventing the deposit of sand. This was a somewhat ambitious object to attain by means of a stream of water 6 feet or 7 feet wide and some 18 inches in depth. It should also be observed that although the size of the watercourse, which will hereafter be called the leat, was limited as regards width, there was practically nothing said as to its depth, and hence the Corporation has always maintained that the whole river could, if need arose, be taken for the use of the town. The question of compensation to the riparian owners of the river, now such an important one, was apparently not considered. Compensation in money was to be paid to the owners of the land through which the leat was constructed. It appears, however, that several owners took a supply of water as part or whole payment for the land taken, and these supplies were given by means of holes of different sizes made through blocks of stone fixed in the side of the leat. The cutting of the leat was commenced in December 1590, and was completed on April 24, 1591, when the water was first brought into the town. The total length of the leat between its commencement at the weir on the Meavy and its termination at its point of discharge into the Sound at Millbay was 18⅝ miles, whilst the distance in a straight line was 10½ miles. The work was done under the superintendence of Sir Francis Drake, who appears to have served his country well in more capacities than one. In the old records of the Corporation it is stated that after the diversion of the river into the new leat complaints were made by the owners of the land adjoining the river below the intake, and a Parliamentary Committee was appointed to inquire into them. It is interesting to note that Sir Francis Drake was chairman of this committee, and it is not surprising to find that nothing more was heard of the matter.

Description of Works.

The area within which the Corporation of Plymouth has the right to supply water is very considerable, and comprises 59 square miles, whilst the area of the borough itself is only 2·2 square miles. The supply is by gravitation entirely, and the works as they now exist are: (1) the weir on the river Meavy, known as the Head Weir; (2) the portion of the leat between the Head Weir and the Roborough reservoir, 8 miles in length; (3) Roborough reservoir containing 1 million gallons, at an elevation of 547 feet above mean sea level, with connecting main to Crown Hill reservoir; (4) Crown Hill reservoir containing 1·3 million gallons, at an elevation of 368 feet, with connecting main to Hartley reservoir; (5) Hartley reservoir, containing 7¼ million gallons, at an elevation of 316 feet, with connecting main to Drake's Place reservoir and the town; (6) Drake's Place reservoir, containing 3·6 million gallons, at an elevation of 146 feet. The total length of distributing mains is about 84 miles.

THE GATHERING GROUND.

The gathering ground, draining to the head weir intake on the river Meavy, is 4885 acres, or 7¾ square miles in area. It is situated on the western slope of Dartmoor, which is a large moor of granitic formation, lying at a considerable elevation, and occupying an area of, roughly speaking, 25 miles by 15 miles. The rainfall on the gathering ground is variable. The average annual fall of rain at Princetown (at the northern extremity) is 80 inches to 90 inches, while at the Head Weir Cottage (at the southern extremity) it is only 59 inches. The average rainfall on the whole gathering ground is 65 inches. The total yield of the gathering ground on the basis of three dry years would be equivalent to more than 12 million gallons per day. As the consumption of water in the town at present is only 4 million gallons per day, there will be no necessity to look for an additional area of supply for some time. There is a very interesting point in connection with the gathering ground, and that is the exceptional character of the dry-weather flow of the river. As the town is almost entirely dependent on the dry-weather flow, since the total storage in the reservoirs is only 13 million gallons, it will readily be seen that the flow must be of larger character than ordinary. Since the time when accurate observations began to be taken, the flow has not been known to fall under 3 million gallons per day, or 1·13 cubic feet per second per 1000 acres, at the end of a long period of drought. The reason of the high dry-weather flow is probably accounted for by the large amount of decomposed granite on the watershed, which takes in the rain-water to considerable depths and allows it to filter slowly out in dry weather. No doubt this is also the reason of the purity of the water, as it undergoes a natural filtration before reaching the streams. The water is naturally of unusual softness and purity, and as a town's supply cannot be excelled.

Distribution and Consumption.

The greatest difference in level between the houses supplied is nearly 600 feet, and it is on this account that a series of reservoirs has been made between Roborough and Drake's Place, to supply the intermediate levels. In order to supply outlying districts, the levels of which varied greatly, and for which it was too expensive to build service reservoirs, it has lately been found necessary to fix pressure-reducing valves. Two have also been fixed in the town to reduce heavy pressures in low-lying districts from 130 lbs. per square inch to 80 lbs. The water supply of about 20,000 people passes through one of the latter, which is the largest in use—viz. 12 inches in diameter—and its working is now very steady. A pressure diagram taken from the lower side of the valve is shown on the wall on an enlarged scale, from which it will be seen that a fairly regular pressure is maintained. The consumption of water in the year 1891 was 5¼ million gallons per day, or 58 gallons per head, and owing to the excessive waste it was resolved to divide the whole of the town into districts, and place waste-detecting meters on the mains. At the present time the consumption is 4 million gallons per day, or 43 gallons per head, although, whilst the reduction has been going on, there has been during the same time a large increase in the water supplied to new consumers. The population supplied is 93,000, of which 91,943 are supplied through the district meters. The trade supply is above the average, being 10 gallons per head. Probably the low price charged for water for trade purposes—viz. 2*d.* per 1000 gallons—is conducive to the usage of a larger amount than would otherwise be the case. During the last four years 30 miles of mains have been laid, the diameters of which vary from 25 inches to 3 inches. Of this length, 10 miles were renewals of old mains. Owing to the fact that the water is taken directly from the river, and is delivered to the consumers without filtration and without having been improved by being stored in large reservoirs, the deposit in the distributing pipes is very great. Many of the pipes when taken up for renewal were quite full, and it appeared difficult to understand how water passed through them in sufficient quantity. It is very probable that had the pipes been well coated and flushed out at regular intervals the deposit would have been much less.

The Proposals for Improving the Supply.

For many years past the question of improving the supply to the town by constructing a large storage reservoir, and by laying pipes to take the place of the open leat, has occupied the attention of the Corporation. In the year 1848 Mr. Nathaniel Beardmore suggested in a letter written to Viscount Ebrington the suitability for a storage reservoir of the site now adopted. For many years the late Mr. Thomas Hawksley was the consulting engineer to the Corporation, and whilst he acted in this capacity he was instructed to prepare plans for submission to Parliament for a reservoir to be known as the Head Weir Reservoir, from the fact that the line of dam ran close to the existing weir. An Act of Parliament was obtained in 1887 for the construction of the reservoir, and the land was bought. Before letting the contract for the dam, trial pits were made across the valley, and it was then found that a layer of decomposed granite covered the bottom of the valley to a considerable depth, one trial pit reaching a depth of 100 feet without rock being found. On these facts being known it was decided to abandon the site, and Mr. Hawksley proposed that powers should be obtained to build a reservoir several miles higher up the valley at the junction of two streams. This reservoir site was between two Tors called Black Tor and Harter Tor, and was to be called the Harter Reservoir. The parliamentary plans were prepared in November 1889, when a controversy arose between two sections of the Council, one of which supported the Harter scheme whilst the other still advocated the Head Weir Reservoir site. A poll of the town was taken in March 1890, and the Harter scheme was thrown out. In July 1891, the author was appointed water engineer to the Corporation, and in December of the same year presented a report to the water committee recommending (1) the construction of a storage reservoir three-quarters of a mile lower down the valley than the proposed Head Weir reservoir, and (2) the laying of a line of 25-inch iron pipes from the proposed reservoir to Roborough, a distance of 4½ miles. The report was adopted, after the opinion of Mr. James Mansergh had been taken with regard to the engineering features of the scheme, and after a report from the late Mr. William Topley, F.R.S., F.G.S., on the geology of the site of the dams.

THE NEW WORKS.

An Act of Parliament was obtained, after considerable opposition, the Royal assent being given on June 9, 1893; and two months later, on August 9, the works were commenced, the Corporation having decided to lay the pipe line and excavate the trenches for the dams themselves. The pipe line was the first work to be taken in hand, and the work was completed by May 19 following, when the pipes were first charged with water. As will be seen from the plan, the line was laid out as nearly straight as was compatible with economy. The pipes form an inverted siphon, the hydraulic mean gradient of which is 1 in 334. They are capable of delivering 10 million gallons per day when the reservoir is full, and 7½ million gallons per day when just kept fully charged, with 2 feet of head on the inlet pipe. The greatest pressure in the pipes is at the crossing of the river Meavy, near Hoo Meavy, where it is 111 lbs. per square inch, but when the reservoir is full, and the valves at Roborough are closed, the pressure will be 150 lbs. per square inch. Every care was taken with the castings to secure perfect pipes, and before the coating was applied each pipe was tested in oil to a pressure varying from 260 lbs. to 300 lbs. per square inch. The pipes are of different thicknesses, ranging from ·82 inch to 1·125 inch. The ends are turned and bored, excepting every sixth pipe, which has a common socket. Air-valves with large and small outlets are fixed at all the elevated points, and scour pipes in all depressions. There are sluice valves, provided with 6-inch bye-passes every half mile. There has not been the slightest trouble with air in the pipes, and this is no doubt owing in a great measure to the fact that the pipes are laid to even gradients, which, while being perhaps a little more costly, is amply compensated for by the regularity obtained in the jointing of the pipes, and by the facility with which the air is got rid of. The pipe line crosses under the Launceston branch of the Great Western Railway, in a tunnel 7 feet 6 inches in diameter. The railway at this point runs along the foot of a hill about 200 feet high, and as the line of pipes after crossing the railway ascends the hill, precautions had to be taken to prevent damage from the bursting of the pipes on the slope. For this purpose the pipes from the entrance to the tunnel to the top of the hill are made of riveted steel plates ½ inch in thickness, with flanged joints. To make the joints the connecting bolts (twenty in number) were put in position, but were not screwed up tightly, a space of ½ inch being left between the flanges. Lead was then run in, and the bolts tightened up. At each end of the length of steel pipes is a manhole for inspection purposes. The main has now been in use twelve months, but has, up to the present time, shown no flaw of any kind. The estimated cost was 26,268*l.*, but it was completed by the Corporation for 23,000*l.* The reservoir which is now in course of construction is known as the Burrator reservoir. It will cover, when completed, an area of 116 acres. Its length will be 1·1 miles, and its greatest breadth half a mile. There will be two dams—one 120 yards long and 77 feet high to top water-line, and the other 160 yards long and 17 feet high. The larger one (which will be referred to as the Burrator dam) will be of masonry of the kind known as Cyclopean rubble, whilst the smaller (which will be referred to as the Sheepstor dam) will be of concrete. The excavations for both dams are now at an interesting stage. From the site of the Burrator dam about 23,000 cubic yards of material have been excavated, and the granite rock laid bare gives promise of an excellent foundation for a masonry dam. There are many irregular joints in the surface rock, but the bed rock has a solid appearance. The principal difficulty in this trench are the vertical seams of soft material, which appear to have been originally open joints in the rock. The largest of the seams has been followed down for some distance, and it will be seen from the section of the trench that it gradually narrowed to very small dimensions. The others have become watertight at the levels shown. The depth of this trench below the river bed is 17 feet. The widest part of the excavation measures about 80 feet. At the level of the river the thickness of this masonry dam will be 62 feet. A roadway 18 feet wide will be carried over the top of the dam on five arches, each with a span of 25 feet. The overflow from the reservoir will flow through the arches and fall down the face of the dam. The Sheepstor trench is of a very different character from the one just described. It is 10 feet in width at the top, and has now been carried down to a depth of 75 feet in the centre. The whole of the trench is in what is known as decomposed granite. It is impossible to say whether this is a correct definition or not. It is difficult to account for the presence of large masses of hard rock in a rounded state in it. Some of this soft granite has every appearance of having been deposited in layers, but had this been the case it appears improbable that the crystals of soft felspars would have remained angular as they are now found. No theory yet promulgated explains satisfactorily the reason of the so-called decomposition of the granites. The most interesting features of this trench are the vertical veins of loose rock, which are shown on the section by black lines. They lie mostly at an angle of about 45° to the trench, as will be seen from the plan, and they are of sizes varying from 1 inch to 2 feet in width. In appearance they are almost exactly like a rubble wall built without mortar. Most of them carry water; in fact, the water in the trench may be said to come entirely from them, so that they act exactly as rubble land drains. The quantity of water daily pumped from the trench is 250,000 gallons. It is solely on account of these veins that the trench has been sunk to such a depth, as it would be unwise to fill it in whilst water was still coming upwards from them. It is tolerably clear that the origin of the veins was some disturbance which cracked the earth's crust, in this case in lines parallel to and in the valley, which would be the point of least resistance, and that the hard rock of which they are formed was ejected outwards in a molten state. Its broken condition is accounted for by the rapid cooling and consequent contraction which would take place. It should be mentioned that the veins pass alike through the hard rock and the decomposed granite. The reservoir when completed will contain 651,000,000 gallons. The total estimated cost of the works is 150,000*l*.

DISCUSSION.

The PRESIDENT: I consider the two papers very practical and most generously prepared, inasmuch as they give such important facts and figures as professional men are not always willing to publish. There are representatives present of important branches of municipal work. There is, for instance, Mr. Charles Temperley, who is interested in hardwood pavements. I am strongly in favour of hardwoods. They want less constant renewal than the softer woods, and they are more sanitary. The improvements made in the character of the London streets during the past few years have given the public the advantage of travelling at the very lowest fares, by reducing the wear and tear of horseflesh and vehicles to a minimum. Alarm as to the slipperiness of wood pavements is mainly due to the nervousness of horses which have not been accustomed to passing from one paving material to another. Hardwood pavement is the pavement of the future, and I am glad to see Plymouth adopting it. We also have present Mr. Walter Jennings, of Lambeth, a sanitary engineer who has done so much for the public welfare; and Mr. J. Parker, the representative of Hassall's pipes, which are now known not only in England but throughout the world. If we can educate municipal bodies up to adopting only the best forms of sanitary pipes it will be found that a high first-cost is the cheapest in the end. We have also present representatives of London scientific journals, and I thank them for attending the meeting. The information that is given at these meetings, the outcome often of a life's study, shows that there are no jealous feelings among the Members of this Association, and I hope the two papers we have heard will be discussed as freely as they have been given.

Mr. J. P. BARBER: I congratulate the authors upon having submitted to the meeting two of the best papers which I have heard read at meetings of our Association. There is nothing in them with which I can find fault; but in reference to Mr. Paton's mention of the use of white Baltic timber for paving I would like to ask if it has been down long enough for a judgment to be formed of its wearing properties as compared with red deal. Another point was as to the racking of the joints with limestone gravel and afterwards grouting with asphaltic mixture. I presume the joints are more than $\frac{1}{4}$ inch in width. My own experience is that a $\frac{1}{2}$ or $\frac{5}{8}$ inch joint was needed to get the gravel in at all. With regard to housing the working classes, the Corporation seems to be fortunate in getting an estimate for dwellings at Prince Rock which works out at 3½*d.* per cubic foot; I hope they will be as fortunate in getting it carried out at such a low figure. Whether it is due to the cheapness of labour and material in the district, or other causes, I am not aware, but it is an unusually low figure, and I hope it will be maintained throughout. In proposing a vote of thanks to Mr. Paton I will also couple with his name that of Mr. Sandeman, both of whom have evidently most carefully and scientifically studied the question of municipal works and the water supply of the town. I am struck by Mr. Sandeman's remarks as to the pipes being laid to even gradients, a point to which water engineers do not pay sufficient attention. By the course he has adopted in this connection Mr. Sandeman has no doubt saved a number of air-valves. The dealing with the veins or fissures in the rock was a very interesting question; perhaps Mr. Sandeman can tell us if he proposes to fill in these fissures, and with what material. Plymouth is to be congratulated on having two officials who can write papers which will so well bear the criticism of a body of experts.

Mr. Gloyne: Mr. Paton's paper makes no reference to the public lighting of the town. Do they propose to introduce the incandescent light? In Eastbourne they are putting up a considerable number of these lights. In the road from the station we have thirty. I find its first cost is considerably more than the ordinary burner, but the light is better and less gas is burned. The cost of renewals of mantles was in some cases heavy, but in my opinion the main cause affecting them was the vibration from the traffic, and is not due to exposed position. I have much pleasure in seconding the vote of thanks.

The votes of thanks were accorded unanimously.

Mr. Paton, in responding, said: In reply to Mr. Barber, I may say that white Baltic is preferred in Plymouth as being of a more uniform texture and less unequal wear than red deal. The cost is about the same. The racking of the joints is done with very finely screened limestone gravel, the joints being ¼ inch wide. Great care is taken to remove all fine dust so as to avoid clogging of the joint, otherwise the grouting will not run to the bottom of the block. Fine gravel removed this difficulty. The estimated cost of erecting buildings at Prince Rock does seem low at 3½*d.* per cubic foot, but Messrs. Hine and Odgers have great experience in Plymouth work, and I think their estimate a safe one. Since the plans were first submitted certain alterations have been made, and these might slightly increase the cost. The estimate of 32,000*l.*

is for the erection of buildings for the displaced population from Southside Street, Ebrington Street, Ham Street, Howe Street and Looe Street; that of 23,000*l.* was to provide for the rehousing of the displaced population in Howe Street and Looe Street alone. The question of the incandescent light came up at the last council meeting. At present the gas supply is in the hands of a company, and the council are seriously considering the advisability of installing the electric light. I have been informed that in Liverpool difficulties have been experienced in lighting and extinguishing the incandescent light.

Mr. SANDEMAN also replied: With regard to my method of dealing with the veins in the rock in the Sheepstor trench, I intend to follow the trench down to a point at which no water enters through the veins. I found as I progressed that they are being closed up naturally. From some of the veins no water is yet entering the trench, and these will be followed down until they become tight or die out in the solid rock.

On the motion of the President, seconded by Col. Jones, V.C., a vote of thanks was heartily accorded to the Mayor and Corporation for the use of the municipal buildings.

At the close of the discussion on the papers, the Members were entertained to luncheon by the Mayor of Plymouth in the Corn Exchange. The Members then drove to the Devonport Dockyard, which by the kind permission of the Admiral Superintendent was open for inspection. The party passed through several of the shops, finishing the visit by an inspection of the "Benbow." From the dockyard to the Hoe was the next feature in the programme. Visits were paid to the Marine Laboratory, to the new landing stage at Phœnix Wharf, to the new fish quay at the old harbour off the Cattewater, to the Outfall Works, and to the Infectious Diseases Hospital, returning to high tea at the Corn Exchange on the invitation of the Mayor.

On Saturday the Members assembled at the Municipal Buildings and were conveyed in waggonettes, first to the Hartley Reservoir referred to in Mr. Sandeman's paper. The reservoir at Roborough was then inspected, and en route to Dousland a stoppage was made at the Belliver Reservoir. At Dousland luncheon was hospitably provided by the chairman and members of the Water Committee, the chairman (Mr. J. T. Bond) presiding. The party then proceeded on foot to the site of the storage reservoir at Burrator, then to the Sheepstor dam. The Members then returned to Plymouth.

DISTRICT MEETING AT KESWICK AND THIRLMERE.

June 15, 1895.

A. M. Fowler, President.

THE THRELKELD QUARRIES.

The Members met at the Keswick Station, from whence they departed for the syenite quarries close to the Threlkeld Station, the next station to Keswick. On arriving at the quarries, the minutes of the last meeting, at Stockport, were read by Mr. Button (the District Secretary), and duly signed by the President (Mr. A. M. Fowler).

Having finished the routine work, the Members placed themselves under the direction of Mr. Harkewitz (the managing director of the company), and were placed in a safe position to see the effects of a blast which was expected to loosen about 2000 tons of stone.

A few minutes were spent in seeing the production of setts, and then a move was made to the stone-breakers. These latter are by Marsden, the engines being by Davey-Paxman, the screens by Richards and Tate and W. Smith. The sizes to which the stones are broken and screened are 2¼ inches, 2 inches, 1¾ inches, 1½ inches and sand. The broken stone is delivered by the screens into trucks, which are run down to a siding and emptied direct into the railway waggons. From the screens the Members went to the factory for the making of artificial slabs for paving purposes. The cement and stone are thoroughly mixed in a revolving mixer, then the frame which determines the size of slab is placed upon a table, to which a constant vibratory motion is given. The mixed material is shovelled in small quantities into the frame, and distributed evenly in the frame by the assistance of manual labour. The constant jigging of the table, it is said, causes a constant agitation of material, and acts to free the mass from air bubbles. When the frame is filled it is taken to a shed and then allowed to remain seven days in the shade, during which a part of the moisture is lost, and the whole sets firm. The slab is then taken into the yard and freed from the frame and left to season for ten weeks, after this period it is fit for use. The Members took great interest in this process, especially as no pressure is applied in the manufacture of the slab.

As regards the stone from the Threlkeld granite quarry, the following is the report of Mr. Frank Rutley, F.G.S.

"The mineral constituents of this rock are orthoclase and mirocline felspars, quartz, calcite and a little epidote and serpentine, some of which has apparently replaced mica. Of these the felspar and quartz are by far the most important, constituting probably in average specimens from 80 to 90 per cent. of the whole mass. A general idea of the hardness of the rock may, therefore, be realised from the fact that the felspar is almost as hard as steel, while the quartz is harder, the point of a knife making no impression upon it. It is a rock closely allied to granite in composition, although it differs from it in structure, its fineness of grain and poorness in mica rendering it really a quartz-porphyry, quartz-felsite, felstone, or elvan, all of which terms are applied to rocks of this character. Such a rock is very likely to be connected with a more closely crystalline granite mass. The evidence in support of the former presence of hornblend in this rock seems wanting, since any such mineral has been altered either into serpentine, epidote, or chlorite, and none of these altered patches show under the microscope any definite crystalline forms, or afford any angles formed either by the faces of crystals or by the intersections of cleavage planes. There is, on the other hand, no evidence to prove that some of the serpentine, &c., may not have resulted from the alteration of hornblend, and if this were the case the rock would then have been originally allied in mineral constitution to a rock of a syenitic type. The felspars have for the most part undergone slight physical change, resulting in a granulated structure, which renders the recognition of their optical characters difficult. The alteration products are very evenly distributed, and occupy as a rule exceedingly minute spaces, so that they decidedly tend to enhance, rather than diminish, the value of this stone for paving setts, since they would, by wearing away more readily than the other parts, help to preserve a rough surface under traffic. On the whole, I am of opinion that it would be difficult to find a more durable or better stone either for setts or road metal; while, if it could be easily got in suitable blocks it would make an admirable building stone, although possibly a rather costly one to dress."

With regard to the crushing resistance of this stone, the following figures are taken from Mr. David Kirkaldy's report of tests taken at Southwark:—

1. Crushed at pounds pressure on one square inch of stone	20,128 lbs.
2. Crushed at tons pressure on one square inch of stone	tons cwt. qrs. lbs. 8 19 2 24
3. Pressure of tons on one square foot	1294 tons.
4. Name of quarry	Threlkeld

The following analysis is by Mr. J. Clifton Ward, F.G.S., as given, in his survey memoir of the geology of the northern part of the Lake district, in the 'Transactions' of the Geological Society 1876:—

Silica	67·180
Alumina	16·650
Lime	2·352
Magnesia	1·549
Potash	2·914
Soda	4·032
Ferrous oxide	2·151
Ferric oxide	·559
Phosphoric acid	·179
Sulphuric acid	trace
Carbonic acid	·885
Carbonaceous matter	·797
Water	·752
	100·000

Last year the output of the quarry reached 80,000 tons. The stone is prepared to the ordinary sizes, as follows:—

Granite Paving Setts.—3-inch cubes, 1 ton covering about 7½ square yards; 3 inches by 4 inches, 6 square yards; 3 inches by 5 inches, 4½ square yards; 3 inches by 6 inches, 4 square yards; 3 inches by 7 inches, 3½ square yards; 3½ inches by 6 inches, 4 square yards; 4-inch cubes, 5½ square yards; 4 inches by 5 inches, 4½ square yards; 4 inches by 6 inches, 4 square yards; 4 inches by 7 inches, 3¼ square yards; 5-inch cubes 4½ square yards; 5 inches by 6 inches, 4 square yards.

Granite Kerb Stones.—Flat kerb, dressed: 10 inches by 6 inches, 10 inches by 8 inches, 12 inches by 6 inches, 12 inches by 8 inches 15 inches by 8 inches, 15 inches by 10 inches. Edge kerb, dressed: 6 inches by 10 inches, 6 inches by 12 inches, 8 inches by 10 inches, 8 inches by 12 inches.

Broken Granite.—Granite macadam, 2¼-inch, 2-inch, 1¾-inch and 1½-inch gauge; granite, in lump or cob, for hand-breaking; granite, hand-broken, 2½-inch gauge; granite, rough lumps for building purposes; granite gravel, ¾-inch gauge, for garden drives and park roads; granite, crushed ⅜-inch gauge, for garden walks and concrete purposes; granite sand, for mortar—half the quantity of lime will do for this, and makes as good mortar as of ordinary sand; 1 cubic yard of broken granite weighs about 18 cwt., consequently, if laid 4 inches thick will cover 9 square yards.

THIRLMERE.

From the quarries the Members drove in brakes through the St. John's Valley to Thirlmere, where they first inspected the taking in and screening, afterwards driving round by the other side of the lake and inspecting the dam. The following is a brief description of this great work.

That a municipality should control its water supply is now becoming a recognised fact. Manchester recognised it so long back as 1846, when the Corporation bought out the company that had constructed the earlier works. The late Mr. J. F. La Trobe Bateman, F.R.S., was early consulted to augment the supply taken over, and prepared the Longdendale scheme, which included the construction of reservoirs having an area of 854½ acres and a capacity of 5985 million gallons, obtained from a catchment area of 19,300 acres in Longdendale. Even this addition has been found inadequate to meet the growing demand of a rapidly increasing district—a demand that has risen from a daily average of 8 million gallons forty years ago to 23, 24, and even to 29 million gallons to-day. In 1877, upon the advice of Mr. Bateman, the Corporation applied to Parliament for sanction to appropriate Thirlmere and the adjacent catchment area, and after considerable opposition the Act of Parliament was obtained in

1879. Mr. G. H. Hill, who had been associated with Mr. Bateman in the Longdendale scheme, was appointed sole engineer, and the work was commenced in 1886. An illustrated account of the whole work will be found in the pages of *Engineering*, in a series of nine articles commencing October 16, 1891, and ending February 5, 1892. The following notes are largely taken from this source, as an addition to the description, statistics and plans furnished to the Members. The works consist, generally, of the adaptation of Thirlmere as a reservoir, including the construction of dams at the outlet of the lake, discharging arrangements, and other works; of an aqueduct 95 miles 1642 yards long, including long lengths of tunnel, cut-and-cover and piping; of wells and valves for regulating the flow of water; of numerous bridges to carry the aqueduct over streams and valleys, those over the rivers Lune, Ribble and Irwell being of an important character; and, finally, of a reservoir at Prestwich, 4½ miles north of Manchester, from which the water will be passed to the city. In the accompanying plan of the lake the natural extent of the lake is shown, as well as the extent when the level is raised 20 feet, and again when raised 50 feet. The rainfall varies in the catchment area from 52 inches to 137 inches per annum, and the estimate is that when the works are complete the storage will provide 50 million gallons of water per day for 150 days, even if no rain falls during that time, without drawing below the original margin of the lake, it being stipulated by the Act that drawing below the natural level shall not take place. The work is to be completed by instalments permitting a flow of 10 million gallons per day to Manchester. The first instalment is completed, and was opened on October 12 last year. The purchase of the watershed, including the lake and wayleave for the tunnels and the cut-and-cover, and for the laying of five lines of siphon pipes across the valleys from Thirlmere to Manchester, and the works as carried out, i. e. all the tunnels and cut-and-cover or concrete tunnels constructed near the surface of the ground to convey 50 million gallons per day, and one line of pipes to convey 10 million gallons per day to Manchester, will cost, roughly, say, 2,500,000*l*. The total cost when the five lines of pipes have all been laid and the lake raised 50 feet, is estimated to be between 4 and 5 million pounds sterling.

The lake lies approximately north and south, the natural flow being towards the north. The valley is bounded at the north by

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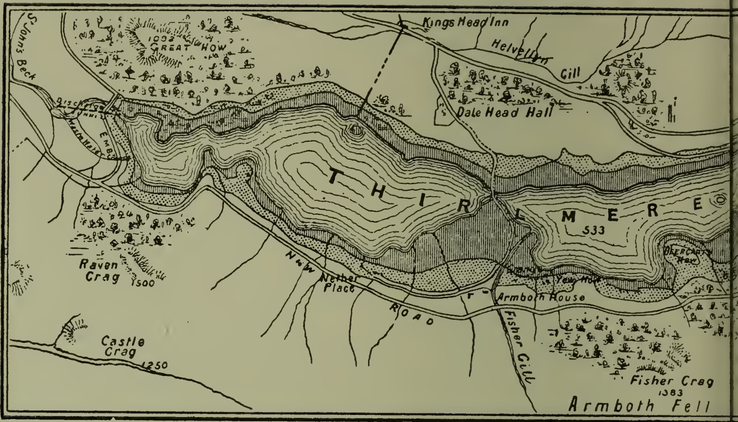

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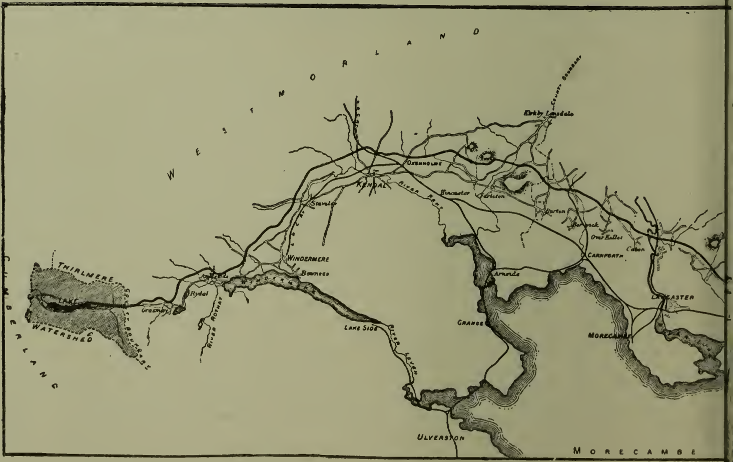

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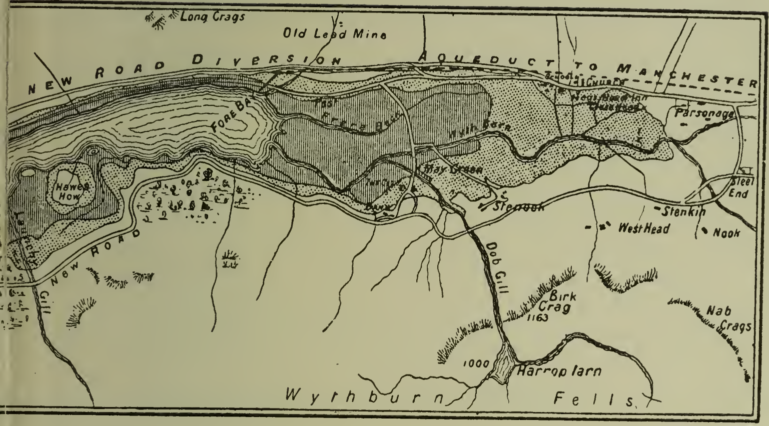

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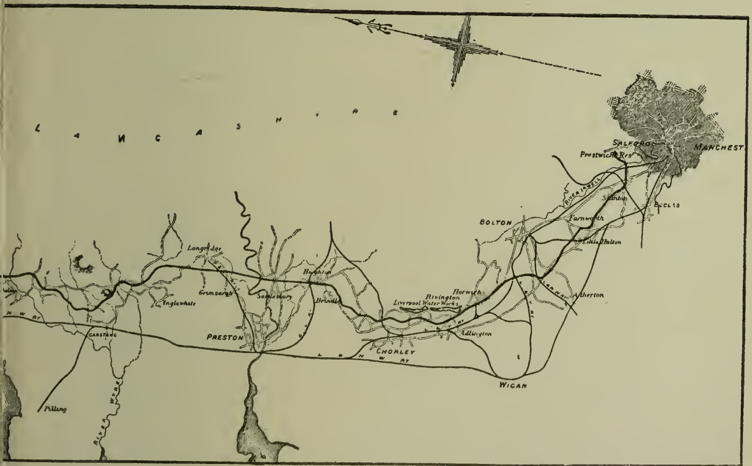

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the hills, Raven's Crag and Great How. Between these is a smaller one not higher than the new water-level, dividing the valley into two, giving a natural outlet to St. John's Beck. It is at this northern end of the valley that a dam has been built, the line of the dam being determined by a rock foundation. A tunnel is driven through the small hill to discharge the water of the lake, and a pipe is laid under the floor to carry off a regulation quantity of water to St. John's Beck. The top of the dam or embankment is 6 feet 3 inches above the level of the lake when fully raised; its length is 857 feet, width at top 18 feet 6 inches, and greatest height from foundation 104 feet 6 inches. The following measurements may now be given:—

Levels of Lake.	Above sea-level. Ft.	In.
Natural level of lake	533	2½
Level when raised 20 feet for the supply of the first instalment of 10,000,000 gallons a day	554	0
Level when raised to full extent of 50 feet	584	0

Length of lake when raised 20 feet, 3 miles 500 yards.
Length when raised 50 feet, 3½ miles 220 yards.

Drainage Area to Lake.	Acres.
Natural drainage area	7,400
Additional drainage area to be hereafter diverted into lake when required	3,600
	11,000

Area and Capacity of Lake.	Area (acres).	Capacity (million gallons).
Natural area	330	—
When raised 20 feet for the supply of the first instalment of 10,000,000 gallons a day ..	565	2,534
When raised to full extent of 50 feet	793	8,135

Compensation Water.	Gallons per 24 hours.
Quantity of water to be discharged into St. John's Beck before diversion of additional drainage area into lake	4,126,125
When lake is raised to full extent of 50 feet ..	5,520,487

In constructing the dam, excavations were carried down a sufficient depth to get a watertight foundation. The base at the lowest part is about 50 feet wide. Along the inner toe of the dam a trench 6 feet wide was sunk to a lower level than the other parts, with an average depth of 4 feet, reaching in some cases to 9 feet. This toe is stepped on either side, and at the ends also a deep excavation was made in the rock face for the front edge of the dam. This is built of masonry concrete, faced on the outside with sandstone from Annan and on the inner side with stone from Longridge, near Preston. The interior of the dam is of concrete, 5 to 1, the sand being ground by crushing rolls constructed by Messrs. Lamberton & Co., of Coatbridge. The finest of the ground sand passes through the $\frac{3}{16}$-inch sieve, and the remainder is put through an ordinary mortar-pan with two iron rollers. Sand or the crushings of Silurian rock were alone used in the construction of the dam. The results of tests made with a cement of about 500 lbs. per square inch at seven days were as follows:—

Description of sand. 3 parts of sand to 1 part of cement.	Number of days after moulding.	Tensile breaking stress in pounds per square inch.					
Standard sand	7	179	187	200	192	184	186
	28	240	232	230	224	231	240
Crushed rock sifted to same size as standard sand.. ..	7	235	250	212	—	—	—
	28	281	282	328			
Crushed rock as received ..	7	235	242	255	—	—	—
	28	335	301	326			

The concrete is laid in layers of 9 inches to 12 inches thick, and plums (large single stones) are put in as close as will allow of the surrounding concrete being made good. These are all laid on edge, and in all cases are bedded in mortar. The heaviest plums used are about 3½ tons.

Various new roads have been constructed, that on the west side of the lake being 5 miles 965 yards in length; one on the east side is 2 miles 242 yards in length, and that across embankment is 1683 yards long. The aqueduct (Fig. 2 shows a plan route) is constructed to convey 50 million gallons a day; its diameter is 7 feet, with a fall of 20 inches per mile. The length from Thirlmere to Manchester is 95 miles 1642 yards, in which there are 14⅛ miles of tunnels, 36¾ miles of cut-and-cover, and 45 miles of pipes. The water is withdrawn from the lake by a tunnel about 100 yards long. At the outer end of the tunnel the water is discharged into a short length of pipe 42 inches in diameter, which passes through a well, where it is commanded by two valves—one worked by manual, the other by hydraulic machinery. The water is then discharged into a straining well 37 feet 6 inches in diameter at the bottom and 40 feet 6 inches at the top. The difference in diameter is due to two sets-off in the interior of the well, one near the foot and the other a short distance from the top. It is 65 feet deep. Strainers are carried on eight cast-iron columns. Each column is attached to a cast-iron base sunk on the rock and bedded on concrete. The straining columns are 20 feet 6 inches long, and are placed 9 feet 2⅛ inches apart, the distance between the sides of the well and the strainers being 6 feet 9 inches. The columns are round, of 22 inches internal diameter, and grooves are formed by flanges 4 inches by 4 inches being cast on either side to hold the strainers, which are dropped into these grooves in sections. In the centre of the well there is a column built up in sections of 10 feet 6 inches long bolted together. The column extends to the top of the well. From this central column there are distance-pieces, bracing together the tops of the straining columns. At the top of the well there again radiate from the central columns cast-iron girders 20 feet long, supported on the walls of the well. These carry a gangway formed of cast-iron plates ⅝ inch thick, having a line of rails round the outside edge of the platform, for the crane used in raising the strainers to be cleansed. There is a washing chamber on the surface level alongside the straining well. It is 15 feet by 12 feet. The strainers are here cleansed by a jet of water working under pressure. There is a building of corresponding size for storage, &c.

To drain the bottom of the straining well for inspection or repair there is placed, 3 feet below the level of the floor of the tunnel, a jet pump. The water, passed through at a high pressure, is taken from the pipe supplying the hydraulic cylinder. The water thus pumped is passed by a pipe into the aqueduct to Manchester. The buildings over the straining well, the valve shaft, the store room and cleansing chamber are all grouped together, forming a very effective architectural feature. The walls are built of the stone of the district, but all stringcourses, quoins, corbels, copings, door and window heads, sills and dressings are of red sandstone from Dumfriesshire. The valves and strainers being many feet below the surface of the ground, windows placed in the vertical walls would not admit sufficient light, but by using glass largely in the roofs the desired light is obtained. The cleansing chamber and the valve chamber are both open to the straining well, and can be entered from the cast-iron gangway carried round the interior of the straining well. The valve chamber has also an entrance direct from the outside, the doorway being large enough for the passage of a valve or the machinery for working the same.

After the inspection the Members expressed their admiration for the excellent way in which the work had been carried out. Mr. Benton, the manager, was present to explain all that was necessary.

From Thirlmere the Members drove back to Keswick, where Mr. Harkewitz entertained them to luncheon at the Keswick Hotel.

Votes of thanks were unanimously accorded to:—

Mr. Harkewitz, for his kindness as the host and for having thrown open his quarries and factory for inspection;

The Corporation of Manchester;

Mr. Hill, the engineer of the waterworks, and to Mr. Benton for the facilities afforded the Members in visiting Thirlmere;

The visitors; and to Mr. Fowler, on the occasion of the last District Meeting under his presidency.

ANNUAL MEETING AT HALIFAX.

June 27, 28 and 29, 1895.

THE PRESIDENT'S ADDRESS.

By EDWARD R. S. ESCOTT, M. Inst. C.E.

I wish to tender to the Members of the Incorporated Association of Municipal and County Engineers my most sincere and earnest thanks for the honour conferred upon me, in electing me President of the Society for the ensuing year ; and, in the words of one lately called upon to fill a very high office in this country, I would add " that while I feel the greatness of the honour, I feel still more deeply the responsibility."

It is usual upon such occasions for the President in his address to allude to some of the passing events of the day, and more especially to the events which come under the notice of the municipal engineer and surveyor.

Perhaps no subject of late years has called forth more attention and consideration than that of sewage disposal, and engineers representing inland towns have found it extremely difficult to produce an effluent suitable to be discharged into any pure water, river or stream.

Throughout the length and breadth of the country we hear of rivers conservancy boards being established with powers, granted by Parliament, equal to, if not surpassing, the provisions contained in the Public Health Act of 1875 ; and we may gather from the proceedings that have already been taken in the matter, that local authorities will no longer be allowed to discharge the raw sewage of their respective districts into any stream flowing through the same.

The present Acts of Parliament have for years given corporations and local boards all the powers necessary to deal with this important subject, yet the progress made in our manufacturing towns to obtain the desired effect has not met with the success that many of us have looked for ; it therefore still remains for the municipal engineer to persevere in this difficult yet interesting branch of the profession, and not for a moment to think of giving in until the streams of every valley and district are flowing with clear, bright and pure water from source to ocean. How is this to be accomplished ? There are several very interesting systems before the public just now which deserve our careful attention and watchfulness.

It is not my intention on this occasion to lay down any hard and fast line, or express my opinion in favour of any definite system for the disposal of sewage. It appears to me to be the duty of all of us (where no scheme has already been adopted) to thoroughly weigh the *pros* and *cons.* of the systems which come under our notice, and recommend for adoption to our respective boards the best known process for the treatment of the sewage of the town or district over which we have the honour to preside.

It is well to remember that a system in every way adequate for a suburban district might in no way answer the requirements of a large manufacturing town. It is thought by many that every available piece of land should be purchased for land filtration, and where land could be obtained at a reasonable price per acre it might be advisable to secure it; yet, in my opinion, this is only a minor point for consideration.

No doubt we all agree that a clear and bright effluent can be produced by land filtration where you have a sufficient area, yet I contend that a bright, clear and pure effluent can be produced by chemical treatment and precipitating-tanks of such a standard of purity as to justify its discharge into any river or stream of the country. The extent of land required must be determined by circumstances—one acre per 1000 of the population, or even half an acre for that number, must in many cases be quite out of the question ; for in my opinion it is evident that in the very near future, with science and chemistry combined, the land required will be reduced to a small area, and that a town with a population of 100,000 will not require one-twentieth part of an acre per 1000 for the treatment and disposal of its sewage.

STANDARDS OF PURITY.

It is with regret that I am unable to place before you any definite standard of purity for sewage effluents. We are left very much to our own resources upon this difficult subject. A pure effluent must be produced, yet the analysis of such effluent that would give satisfaction to the Rivers Conservancy Board is at present unknown to us.

Let me upon this subject quote a paragraph from the *Chemical Trade Journal* of February 23 last, which in a few words places the question very clearly before us. Referring to the evidence given at the trial lately taken against the Salford Corporation, it says: "The Mersey and Irwell Joint Committee have taken upon themselves the establishment of a certain limit of impurity for sewage effluents. Knowing the difficulties of fixing an unalterable numerical standard, the Rivers Pollution Commissioners only ventured so far as to recommend certain limits of impurity in the matter of solids and such like. The Joint Committee have, however, advanced further into the unknown, and elected to judge the quality of effluents by comparison with an imaginary effluent which would give upon analysis not more than 0·1 grain per gallon of albuminoid ammonia, 0·25 grain of absorbed oxygen by 15 minutes' test, and 1·0 grain by the three hours' acid permanganate of potassium test." We have here a very high standard of purity at which to aim.

The same paper adds, "We shall not waste time by discussing these standards, since they are virtually worthless, the principle of their adoption being hopelessly futile in theory and practice."

COMBINED DRAINAGE.

This is another subject of importance which has received considerable attention of late. It is to be hoped that before long the law relating to this matter will be altered, or perhaps it might be more correct to say that the mode of reading the section bearing upon the subject will be amended.

We must all have noticed with regret the poor progress made by the Amendment Bill in the present session of Parliament. The Bill has been systematically blocked upon every occasion, so that no further attempt will be made to carry the Bill through this session.

Hospitals.

Municipal engineers are often called upon under very short notice to prepare plans and erect fever and small-pox hospitals. When the costs of such buildings are defrayed out of the rates there is not much difficulty to contend with, and no time is lost in executing the works; but when the intended erection comprises a permanent administrative block for the medical officer, officials, nurses and staff, wards, &c., and application is made to the Local Government Board for sanction to borrow money for the erection of such buildings, the question becomes one of considerable importance.

The cost of the new hospital does not appear to enter into the consideration of the head Department, and when waited upon with some modest design, of an inexpensive character, in every way suitable to meet the pressing requirements of the epidemic, you are most politely handed a carefully drawn-up report upon the provision of isolation hospital accommodation for local sanitary authorities, accompanied by several specimen sheets of plans and sections showing administrative block and wards drawn to suit the requirements of nearly every district, with the intimation that plans drawn to correspond with these specimens are the only plans the Department will consider or accept. You are therefore obliged to return home, and with all speed produce another set of drawings before any sanction will be granted to borrow the amount of money required. This delay might lead to very serious consequences where an epidemic was at the time raging, and to avoid any unnecessary delay, let me suggest to the Members about to erect fever or small-pox hospitals to approach the officials of the Local Government Board in the first instance; they are ever ready and willing at all times to give full information respecting the requirements of the Board regarding the accommodation to be provided for an isolation hospital.

The plans you notice on the walls of this Council chamber practically comply with the requirements of the Local Government Board for a small-pox hospital for a town with a population of about 100,000. The building has not been erected; the site has been secured, of 65 acres, about two miles from the Town Hall, upon high ground. Every provision is made for proceeding with the works as soon as the Health Department of the Corporation considers the time has arrived for the erection of the same. I may add that the approximate cost of the designs exhibited is 12,000*l.*, exclusive of land.

In the present day it is absolutely necessary that every authority should be fully alive to the importance of providing fever and small-pox hospitals arranged upon the latest and most modern principles the Local Government Board require.

MEMBERSHIP OF THE ASSOCIATION.

The time appears to have arrived, in the interest of this Society, that a slight alteration should be made in the articles of association. At present no person is eligible for membership unless he holds a chief appointment directly under a local authority. Then, again, no Member who resigns his appointment can in future fill any office on the executive. This, you will perceive, at once shuts out some of the best talent and most worthy Members of the Association from taking any part in the government of the Society. Also, the rising men in the profession who fill important offices as deputy engineers or chief assistants in many of the provincial towns fail to obtain the benefits arising from the papers read, and the discussion upon the subjects brought before us, yet through no fault of their own they are precluded from taking part in our deliberations. This is a most difficult question to solve, and I am anxious to see it brought under the careful consideration of the Council; while wishful to see such men admitted to our Meetings, I fail at present to see how the object is to be accomplished.

BENEVOLENT FUND.

Another urgent question is the formation of a benevolent fund to grant relief to the Members, and assist their widows and orphans in times of temporary affliction or distress, and I think the object might be carried still further, so as to provide small annuities for aged and afflicted Members permanently disabled from following their vocation. A previous President brought forward a scheme somewhat on the lines suggested, and I am sorry the proposal received so little attention. Should the subject be again considered, I trust the Members will give it their favourable support.

CONCLUSION.

The work of a municipal engineer is ever increasing. Consider for a moment the strides science and engineering have taken during the last quarter of a century. In the construction of railways, the erection of bridges and canals, the introduction of tramways with every known means of haulage, our extensive water supply, the purity obtained in the manufacture of gas, the electric lighting in all its fascinating beauty, the improvements in our towns, the treatment and disposal of sewage, together with the hundred and one routine duties a municipal engineer is called upon daily to perform, well might we ask where his education ends; and the only reply to the question must be—it ends with his life. It is a life-long service, dedicated from the time he takes office to the end for the benefit and welfare of the community at large, and the district over which he has the honour to preside in particular.

At times we all have exceedingly anxious and difficult duties to perform—difficult because they require deep thought and perseverance in carrying out the works laid upon us, and anxious because it has not at all times been easy to foresee the result so much desired; yet to my younger brethren let me quote a motto in one word which has often helped me in times of difficulty and doubt—namely, "Action"—leaving for the moment the results in other hands, feeling assured that in engineering the faithful toiler will not fail to receive his just reward when his day's work is ended.

Some, we know, are born great, some achieve greatness, and some have greatness thrust upon them. It is not for us to seek to have all things happen as we would choose them, but rather choose them to happen as they do—and so shall the current of our lives flow free and even through all difficulties that may arise. The borough engineer should always remember the lines—

"If you your lips
Would keep from slips,
Five things observe with care:
Of whom you speak,
To whom you speak,
And how, and when, and where."

It is not my intention to detain you longer this morning. I may have other opportunities during the ensuing year of airing my views, together with your own, upon subjects of importance as they present themselves from time to time. Gentlemen, I sincerely thank you for your great attention to my remarks, and wish you one and all a very hearty welcome to the good old town of Halifax.

Mr. H. PERCY BOULNOIS: A very pleasing duty devolves upon me, which I have been asked to perform, that of proposing that the best thanks of this meeting be given to Mr. Escott for his Presidential address. I have particular pleasure in moving that resolution, for I have been struck all through the address with the remarkable ability with which it has been prepared, the amount of information it gives us, and its literary merit. Fortunately for us the Presidential address cannot be discussed, otherwise I am afraid we should be here for a very long time, as it bristles with contentious matter. The question of sewage disposal alone is one that I know would occupy us for a week. There is another matter which I may perhaps be allowed to mention, that of purity of effluent. It is curious to note that chemical analysis appears to be the only thing that is mentioned in the Acts of Parliament dealing with River Pollution, and is also thought by a great many people to be sufficient, but the bacteriological investigation is far more important, and is one which should command our attention. The President also mentioned the question of combined drainage, which gives me an opportunity of explaining to the Members of the Association why my brother, who represents East Marylebone in Parliament, blocked the Bill to amend the Public Health Act with respect to sewers, and which Act has recently been withdrawn. His reasons were primarily that he thought it was for the Government, and not for a private individual, to define what is combined drainage; and secondly, he thinks—and though I have tried to convert him I regret to say he still holds the same opinion—that it would inflict a great hardship upon owners of property. Mr. Escott has referred to the constitution of the Association. That has given us a good deal of thought, but there are absolute difficulties in the way as to enlarging its scope which cannot be overcome. I agree with the President that the work of the Municipal Engineer is multifarious; the City Engineer has really to know all that is going on all around him, and as the President tells us, his education only ceases at his death. I have very great pleasure in moving this resolution. I know that in Mr. Escott all the best traditions of this Association will be carried out during his year of office, and

I heartily congratulate him on the position he so worthily fills. Gentlemen, I have much pleasure in proposing a vote of thanks to our President for his address.

Mr. A. T. Davis: I have very great pleasure in seconding the vote of thanks to our President for his address. The manner in which Mr. Boulnois has moved the vote of thanks leaves very little for me to say in seconding it.

Mr. C. Jones put the proposition to the meeting, and it was adopted unanimously.

ROYTON SEWAGE WORKS.

By T. S. McCALLUM and W. NAYLOR.

The urban sanitary district of Royton contains 2112 acres of land, and a population of about 14,000. The question of purifying the sewage was taken in hand by the late Local Board, who selected a site at a point on the outskirts of the district where the two principal valleys meet, the built portion of Royton being situated along the two valleys and on the ridge between them. A plot of land about 15¾ acres in extent was purchased for sewage purposes, although the Local Government Board sanctioned the scheme with only 5 acres—the extra area being procured because, by taking the whole plot, terms were arranged which seemed more advantageous than if the smaller plot only had been taken. The price given for the 15¾ acres was 8445*l*.

The works constructed upon the site include a refuse destructor as well as sewage purification works. The latter portion of the works was completed in August 1892, when the purification of the sewage began and has continued uninterruptedly ever since. The destructor was finished in 1893, and has also been in constant use since.

The sewage of Royton is almost entirely domestic, but probably nearly one-third of the houses have not yet been connected with the town's sewers. The dry weather flow of sewage is at present about 180,000 gallons per day, but a few months ago arrangements were made to deal with a quantity of water pumped from a colliery, which the river authorities declined to admit into the river untreated. The colliery company pay for the treatment, although it is found that the iron contained in this colliery water (about 135,000 gallons per day) is of use in assisting the treatment of the ordinary sewage. The tests, however, which have been made at the works were with the ordinary sewage only, the colliery water being temporarily excluded. The sewage is delivered at the works from two main outfall sewers, and is received in a small detritus chamber containing a strainer with cleansing rakes attached. After passing the strainer the sewage actuates a 6-foot diameter water-wheel, which supplies power for working one of Keirby's precipitant mixers and distributors.

The precipitant used is "ferozone," and is supplied by the "International" Company in the lump form. The ferozone having been added, the sewage passes along a zigzag channel on its way to the settling tanks. The tanks are six in number, their dimensions being 105⅓ feet by 22 feet, and averaging in depth when full about 6½ feet; their combined capacity is about 560,000 gallons. They are at present worked on the intermittent or quiescent system, but can be worked on the continuous-flow system if necessary. The walls, constructed of brickwork in cement, are faced with blue bricks. The floors are of concrete. The usual inlet and outlet fittings are of course provided. The tanks as they stand can deal with over one million gallons of sewage per 24 hours.

The tank effluent passes from the tanks to a channel which is formed along the ends of the filter beds; the latter are eight in number, and have a combined area of 800 square yards.

Each bed is 60 feet long by 15 feet wide. The walls are of brick and the floors of cement concrete. The special medium employed in the filters for completing the purifying process is "polarite," which is protected by a layer of sand as a strainer for arresting any light flocculent matter which may pass over from the settling tanks. The filters are made up of the following layers:—

Sand	10	inches thick.
Polarite and sand (mixed in about equal proportions)	12	,,
Pea gravel	2	,,
Bean gravel	2	,,
Walnut gravel	3	,,
Boulders (with drain tiles between) ..	6	,,

The drain tiles are all connected with a main channel running the whole length of each filter at one side, and the tiles are also connected with a ventilation conduit at the other side of each filter. The tank effluent is admitted to the filters by means of a penstock, and is conducted to the surface of the filtering media by means of an iron channel running the full length of each bed and in the centre thereof, the sand being level with the edges of the channel and having a rise of about 3 inches towards the sides. The effluent flows on this channel at each end simultaneously.

Each filter has a separate outlet valve for controlling the rate of outflow of the filtered effluent, as also for use in connection with the upward washing arrangement which is provided. For the latter purpose all the outlets are connected together in a main outlet pipe, with a main valve at the outlet as well as secondary valves dividing the filters into two groups of four each. By these means the filtered effluent from any one or more filters can be made to pass upward through any filter it is desired to cleanse, at the same time as other filters are either at rest or working in the ordinary way. When a bed is being washed, the surface is swept lightly with a brush and the dirty water flows into the central channel, and by means of valves either passes on to a plot of land specially prepared to treat it, or is pumped back to the tanks for retreatment. The cleansing of each bed takes two men rather less than one hour; the filters generally work three to four days without being washed. The polarite has never been renewed. Once a year the top layer of sand is dug over but not removed or renewed.

The filters when in use work at the rate of about 1000 gallons per square yard per 24 hours, but no filter works for 24 consecutive hours; experiments have proved that the filters can work at the rate of over 6000 gallons per square yard per 24 hours. The filtered effluent passes into an open brick channel, and thence direct to the river Irk. There is sufficient area for the filtered effluent to be further treated upon land (by gravitation), but this has not been found necessary, and is not done.

The sludge from the settling tanks is swept by squeegees into a main sludge pipe. This pipe is emptied at the close of each day, and the sludge flows into a sludge tank under the sludge-pressing building, which will now be described.

The building is of brickwork faced with red pressed bricks; the roof is of iron and slates. It is situated a little to one side of the tanks and filters. The configuration of the ground rendered it an easy matter to so arrange that the sludge pressing and refuse destructor could be under one roof, and so contribute to economical working. The building is all together 100 feet long by 64 feet wide. It has two main floors, the upper containing engine, sludge presses, workshop, lime store and tipping platform for ash-pit refuse. The ground floor contains the destructor furnaces, cremator, boiler and sludge cake store. There is a small basement for a mortar mill and one for the sludge rams. There is a good cart-road to each of the three levels. The sludge-pressing plant—with boiler—is confined to one end of the building, and although there are doors of communication, is quite distinct from the destructor. The engine has an air cylinder directly connected to it; the principal dimensions are :—Steam cylinder, 8 in. diam. by 16 in. stroke; air cylinder, 5½ in. diam. by 16 in. stroke.

The air receiver is of steel, 10½ feet long by 3 feet diameter. The presses are two in number (with space for two additional ones), each press having thirty chambers 30 inches by 30 inches. There are two sludge rams. The sludge tank (which has a drainer for running off the supernatant water accumulated during the night) measures 15 feet by 11 feet, with an average depth (when full) of about 8 feet of sludge. A tram runs underneath the presses, with a tram-road to the cake store and one to the top of destructor furnaces. The floor of the engine and press room is about 18 inches below the feet of the sludge presses. The water pressed from the sludge is pumped back to the settling tanks for re-treatment.

There are four destructor furnaces and space for two additional ones. The furnaces have sloping rocking bars and are provided with steam jets, but it is not found necessary to use the latter. A fume cremator is provided, which can work either with oil or coke. The waste heat from the destructor heats a tubular boiler for generating steam, which is used for driving the air compressor for sludge pressing. The chimney shaft is of brick, and about 210 feet high. The following are the principal dimensions in connection with the destructor, boiler, &c. :—Grate area, 25 super. feet, each furnace; boiler, 12 feet by 7 feet; flue, 5 feet 6 inches by 4 feet, semi-arch over.

The following particulars are extracted from the manager's reports on the works for the months of April and May 1895 :—

March 30th to April 25th inclusive.

Sewage, &c., treated	8,300,000 gallons.
Ferozone used	7750 lb.
Sludge cake produced	53 tons.
Lime used for pressing	5592 lb.
Ash-pit refuse dealt with by 3 furnaces ..	328 tons.

Working expenses :—	£	s.	d.
Sewage purification (labour)	10	11	8
Ferozone	12	1	10
Sludge pressing (labour)	6	3	0
Lime	2	13	0
Destructor (labour)	12	11	3
General labour	4	9	5
	£48	10	2

April 25th to May 23rd inclusive.

Sewage, &c., treated	6,860,000 gallons.
Ferozone used	6610 lbs.
Sludge cake produced	51½ tons.
Lime used for pressing	5936 lbs.
Ash-pit refuse dealt with by 3 furnaces	319 tons.

Working expenses :—	£	*s.*	*d.*
Sewage purification (labour)	10	15	0
Ferozone	7	7	6
Sludge pressing (labour)	6	1	9
Lime	2	13	0
Destructor (labour)	13	5	0
General labour	4	12	4
	£44	14	7

The destructor and sludge-pressing plant were supplied by Messrs. Goddard, Massey and Warner.

The total cost of the Sewage Works (including the destructor and machinery, but exclusive of land) was about 12,000*l.*

T. S. McCallum.

The trials at the works were made with the help of Mr. McCallum and other assistants on Friday, the 24th of May, for machinery and refuse destructors, and Tuesday, the 28th, for raw sewage and effluent only.

The raw sewage was sampled every quarter of an hour from 10 A.M. until 2 P.M. The quantity of sewage treated was 42,250 gallons, to which was added 53 lbs. of precipitant (ferozone), or 8·8 grains per gallon. This was allowed to settle until 6 P.M. The filters were then put into operation, and were running from 6 o'clock to 6.50, samples also being drawn every ten minutes. At 6.50 the head of water on the filter had fallen 6·5 inches, which is equivalent to 30·6 gallons per square yard per fifty minutes, or 880·8 gallons per square yard per twenty-four hours.

The results of this treatment are set out in the following table:—

RESULTS EXPRESSED IN PARTS PER 100,000.

Nature of Sample.	Taken by	Date.	Dissolved Solids.			Suspended Solids.			Gross Solids.			Free Ammonia.	Albuminoid Ammonia.	Oxygen absorbed.	Chlorine.	Nitrates.
			Mineral.	Volatile.	Total.	Mineral.	Volatile.	Total.	Mineral.	Volatile.	Total.					
Raw Sewage	W. Milner	May 28, 1895	50	26	76	14	21	35	64	47	111	2·788	·694	5 mins., 3·2 4 hrs., 8·2	6·6	0
Tank effluent	W. Milner	„	51	21	72	5	3	8	56	24	80	2·636	·342	5 mins., 1·4 4 hrs., 4·0	6·1	0
Filter effluent	W. Milner	„	64	28	92	0	1	1	64	29	93	1·132	·128	5 mins., ·8 4 hrs., 1·0	6·0	3·7

This shows that the percentage of reduction brought about is

	Per cent.
For total solids	16·2
„ albuminoid ammonia	81·5
„ oxygen absorbed	87·8

The composition of the precipitant was:—

	Per cent.
Silica	5·75
Moisture (free)	20·09
Ditto (fixed)	12·31
Sulphate of alumina	38·23
Ferrous sulphate	4·03
Lime, magnesia, &c.	19·59
	100·00

The actual amount of sludge produced was not calculated, as this is very variable, according to the quantity of precipitant used and the length of time it has been standing. Its composition, pressed, however, was:—

	Per cent.
Water	49·23
Organic matter (including fixed ammonia, ·68) ..	21·66
Silica	9·54
Oxides of iron and alumina	9·89
Phosphoric acid (·514), lime, magnesia, &c. ..	9·68
	100·00

Boilers and Destructors.

The trial of boilers and destructors was carried out on the lines suggested in the report of Mr. Michael Longridge, M.I.C.E., for 1887 to the Engine, Boiler and Employers' Liability Insurance Company.

Four furnaces were working from 11.45 A.M. to 5 P.M., or 5¼ hours. The start was made with the hoppers, furnaces, boiler pressure and water line at points noted, at which points also the trial was finished. The amount of refuse burned was weighed out in 98-lb. lots, and amounted to 9996 lb., or 4·46 tons. The ash and clinker weighed out from this was 4638 lb. (2·07 tons), or 46 per cent. of the input. The self-evident incombustible matter—such as tin cans, &c.—was sorted out from the refuse and not weighed in; but it averages, I am informed, all the year round about 2·2 per cent. of the carted refuse. The water evaporated from this was 399·8 gallons, equal to 3998 lbs., or ·40 lb. of water per lb. of refuse. This was evaporated straight from the filter-beds at a temperature of 58° F. Calculating the water evaporated from and at 212° F., it would amount to ·46 lb. of water per lb. of refuse. Now this result appears very low, especially side by side with trials of refuse destructors which have been recently published, claiming evaporation of about 2 lbs. of water per lb. of refuse, and it was really this very low result at a preliminary trial which prompted this more careful trial and investigation. The analysis of the refuse as sampled from 102 tins weighed out was:—

	Per cent.
Moisture, dried at 212° F.	25·3
Volatile matter	28·2
Ash	46·5
	100·0

A sample of the refuse dried contained:—

	Per cent.
Combustible carbon	11·2
Combustible hydrogen	·12

The calorific value of the refuse dried, therefore, deducted from this analysis is 1693 (taking the calorific value of carbon at 14,545 and hydrogen at 53,337), or about one-seventh of good steam coal.

Tested practically with a calorimeter, the carbon value of the refuse was so low that combustion even in oxygen mixture was impossible, but mixed with a weighed quantity of coal, the calorific value of which was previously determined and afterwards deducted, the calorific value of the waste was 1702. It was preferred, however, to take the theoretical figure, as the difference between that and the practical test is represented only by less than one-tenth of a degree on the thermometer, to read which was impossible with the thermometer used.*

As the refuse, however, is here calculated dry, and it really contained 25 per cent. of moisture, its calorific value is ·75 (1693) = 1269; but even this is not available, for the 25 per cent. of moisture must be evaporated from the refuse representing 1269 units, at the expense of its own inherent heat, before any work can be got out of it. The temperature of the refuse as fed in was 58° F., and the thermal units required to evaporate ·25 lb. of water from 58° F. at atmospheric pressure $= \frac{1146 - 58}{4}$ = 272 thermal units. This brings us now to the real value of the refuse, viz. 997 (1269 − 272) thermal units per lb. wet.

Let us now look how these 997 units of heat are disposed of.

Heat lost by Drawn Clinker.—One lb. of refuse produced ·46 lb. ash and clinker. This clinker was allowed to lie, however, in the ash-pits until it reached a temperature of only 500° F., and was then wheeled out. The heat given off, therefore, in falling to this temperature, would enter the furnaces with the draught.

* Determination of calorific value of coal (2 grams coal and 1934 grams water taken):—

	Deg. F.
Original temperature of water	62·0
Final ,, ,,	74·5
Difference	12·5
Add 10 per cent. for heat retained by copper cylinder	1·25
	13·75

Calorific value in B.T. units = 13,296·25.

Determination of calorific value of refuse (2 grams coal, 2 grams refuse, and 1934 grams water taken):—

	Deg. F.
Original temperature of water	63·0
Final ,, ,,	77·1
Difference	14·1
Add 10 per cent. as before	1·41
	15·51

Calorific value of total	14,998
,, ,, coal only	13,296
,, ,, refuse	1,702

·46 lb. × ·17 (specific heat of clinker) × 442 (500 – 58, number of degrees raised) = 34·5 thermal units.

Heat lost by Unburnt Carbon in Clinker.—The dry clinker contained 1·8 per cent. of unburnt carbon, which is equivalent to ·008 lb. per lb. of refuse burnt. ·008 × 14,545 = 116·37 thermal units, also lost.

Heat lost by Heating of Products of Combustion, Excess Air and Superheated Vapour.—Samples of the gases drawn from the flues consisted on the average of:—

	Per cent.
Carbonic anhydride	4·7
Oxygen	14·5
Nitrogen	80·8
Carbon monoxide	0·0
	100·0

Or, since air contains 21 per cent. oxygen and 79 per cent. nitrogen, we may write it down:—

	Per cent.	
Carbonic anhydride	4·7	Products of combustion.
Nitrogen	26·3	
Excess air	69·0	

This result, owing to the nature of the refuse burnt, is very much different to what takes place in a good coal furnace, where the products of combustion are about double the above and the air in excess about half. Now this excess of air as well as the products of combustion must be heated to the exit temperature of the flue, which, as recorded by the thermometer, averaged 356° F.

The weight of carbonic anhydride per lb. of refuse equals 3·66 × ·075 (number of lbs. carbon burnt) = ·2745 lb. $\frac{\cdot 2745}{\cdot 122}$ = 2·22 cubic feet, and since the composition of the gases shows the carbonic anhydride to be 4·7 per cent., the total volume of gases per lb. of refuse will be $\frac{2\cdot 22 \times 100}{4\cdot 7}$ = 47·2 cubic feet, and this 47·2 cubic feet will be made up as follows:—

	Cub. ft.			Lb.
Carbonic anhydride	2·22,	or weight per lb. of refuse =	2·22 (·1222) =	·2708
Nitrogen	12·4	” ”	= 12·4 (·078) =	·9672
Air	32·5	” ”	= 32·5 (·081) =	2·6325
Total				3·8705

To the weight of these gases must also be added that of steam formed by the combustion of the hydrogen in the refuse, which was ·12 per cent. dry. The actual weight would therefore be ·75 (·12) = ·09 per cent. = ·0009 per lb. hydrogen, = 9 (·009) = ·008 steam. The 25 per cent. of water in the refuse also, existing as moisture, must be added to the gases, which, of course, as steam would have the same weight, viz. 25 lbs.; and, lastly, the aqueous vapour in the atmosphere, which amounted to ·04 lb. in the 48·2 cubic feet of air drawn through per lb. of refuse. The weight of aqueous vapour in this 48·2 cubic feet of air is corrected for temperature and pressure at the time of the trial.*

From the above calculations the following table concerning the heat carried away by the exit gases can be drawn up:—

Name of Gas.	Weight of Gases.	Specific Heat.	Heat Capacity.	Number of Degrees F. raised.	Thermal Units.
Carbonic anhydride	·274	·216	·059	298	17·6
Nitrogen	·967	·244	·236	298	70·3
Air	2·632	·238	·626	298	186·5
Aqueous vapour ..	·040	·481	·019	298	5·6
Water in refuse ..	·250	·481	·120	144	17·2
Steam from hydrogen in refuse ..	·008	·481	·004	144	·6
				Total ..	297·8

In addition, however, to the calorific value of the refuse calculated as sensible, the heat contained in the entering air, vapour and fuel must also be added to that which is sensible in the refuse. This is as follows:—

Fuel: 1 lb. × ·2 (specific heat) × 26 (number of degrees above zero) = 5 units.

Air: 2·632 lb. × ·238 (specific heat) × 26 = 16·2 units.

Aqueous vapour: ·04 lb. × ·481 (specific heat) × 26 = ·5 units.

On the above results the following balance-sheet may be drawn out, which shows the loss by radiation and heat not otherwise

---

* $$\frac{48{\cdot}2 \times 29{\cdot}9 \times (1 + {\cdot}002 \times 26)}{29{\cdot}02 \text{ (actual pressure − tension aqueous vapour at 58° F.)}} = 52{\cdot}2.$$

$$52{\cdot}2 \times {\cdot}00077 = {\cdot}04.$$

accounted for, to be only 72 thermal units per lb. of refuse burnt, or 7·0 per cent.

Dr. Cr.

				Per cent.
Calorific value, 1 lb. wet refuse	997	Heat transferred to water	498	48·89
		Heat lost by chimney gases:—		
Heat in fuel	5	Carbonic anhydride	17·6	1·73
Heat in air	16·2	Nitrogen	70·3	6·90
Heat in vapour	·5	Air in excess	186·5	18·31
		Heating and superheating vapour	5·6	·55
		Superheating moisture in refuse	17·2	1·69
		Superheating steam from hydrogen in refuse	·6	·06
		Heat lost by drawn clinker	34·5	3·29
		Unburnt carbon in clinker	116·4	11·42
		Balance, by radiation, &c.	72·0	7·07
	1018·7		1018·7	99·91

SLUDGE PRESSING.

The steam generated was used for sludge pressing, but it was impossible to run the compressor at a uniform speed throughout the 5¼ hours from the very nature of the work. But when the condition of the rams permitted it, the compressor was run at its normal speed of 130 revolutions right through the receiver at 100 lbs. into the rams. When this was not possible, the ram was shut off from the receiver and the latter run up to 100 lbs. and then opened on to the rams, the falls in pressure being noted, as well as the temperatures of the receiver. By this means the amount of air used for sludge pressing could be calculated. The amount of dry sludge turned out by each press averaged 2025 lbs., or 18·9 cwt. at each pressing, which is equivalent to 150·67 cwt. wet, the wet sludge containing 88 per cent. water. To compress this the compressor was running at 130 revolutions right through the receiver at 100 lbs. for 59 minutes, delivering 257·4 cubic feet of air at 100 lbs. pressure and 225° F. into the rams. This at 58° F. measures only 194·6 cubic feet, the reduction on cooling being 24·3 per cent., though, of course, some compression in the ram may have taken place before the whole mass of air had cooled.

To this must now be added 62·3 cubic feet turned in from the receiver (in 18·8 minutes), making a total of 256·9 cubic feet for two presses, or 135·9 cubic feet of air required per ton of sludge dry, which is equal to a mean pressure in the ram of 45·5 lbs. From the diagram it will be seen that the compressor was indicating 7·10 horse-power in the steam cylinder, loaded, and 1·494 horse-power, light; but the effective horse-power here is not the difference between the one and the other, for as the air is not cooled during compression, owing largely to the leakage of hot air, a certain amount of work is afterwards lost when it becomes cooled and the pressure falls in the ram. The diagram which would have been made in the air cylinder had the air been thoroughly cooled, is represented by the dotted isothermal curve, or perhaps it might be termed the cold air curve. The actual air delivered per stroke at 100 lbs. and 225° F. was only ·2333 cubic feet. It will also be noted here that even the air which was compressed leaked back again from the receiver to some extent, owing to the check-valve being out of repair. This was noted at a preliminary run a few days before this recorded trial and pointed out to the Board, who reported to the authors that the valve had been repaired. It was only after the actual trial had started that the diagram disclosed the fact that it had not been effectually remedied. The curve which the back-pressure line should take is shown by the lower dotted line, allowing $\frac{1}{4}$ inch clearance. An allowance has been made for this leakage in calculating the actual amount of air admitted to the rams, though no deduction was made for the difference in temperature between the discharged air and the air which leaked back.

It would be manifestly unfair, owing to leakage, to refer to the indicated horse-power per hour per ton of wet sludge pressed, or, what is the same thing, per cubic foot of air delivered to the rams at 100 lbs., for, although the slipping air would react on the back-stroke, a given volume of slipping air at a given pressure represents really more work than the same volume at the same pressure on the forward stroke, owing to the fall in temperature after delivery. Again, the relation between the light load and working load will be the same whether leakage is going on or not, so that in case leakage does exist, the indicated horse-power per cubic foot delivered will be much higher than in the absence of leakage.

Since the air compressor was not running either uniformly or continually during the $5\frac{1}{4}$ hours' trial, the quantity of steam used per stroke of the piston could not be measured by the water evaporated. The diagrams, however, show it to be 41·74 lbs. per hour per indicated horse-power. To this must be added 1 per cent. condensed in the 80 foot length of steam pipe, including five bends, as recorded by tests made with a globe calorimeter, = 42·15 lbs. The same instrument recorded little or no priming in the boiler, which could only be expected considering the comparatively low pressure—70 lbs.—slow consumption, and large dome. To the 42·15 lbs. must be added 10 per cent. for cylinder condensation, which brings the consumption to 46·36 lbs. Now, since the boiler evaporation was $\frac{\cdot 4 \times 9996}{5 \cdot 25} = 639 \cdot 6$ lbs. per hour, the indicated horse-power possible, had the compressor been working continuously, was 13·7, or 3·4 horse-power per hour per cell. The diagrams also show that the actual work performed on the piston was 224,598 foot-lbs., which are equivalent to 290·9 units of heat per minute. But to do this work the steam consumed per minute was 5·48 lbs., containing 6295 units of heat; the difference between the two, viz. 6004, being lost by radiation or carried away by the exhaust.

The balance-sheet may now be continued, to show how the 498 units of heat entered as transferred to water are disposed of finally.

Dr.	Thermal Units.	Cr.	Thermal Units.
Transferred to water, from refuse, &c.	498	Lost by condensation in steam pipes	4·98
		Carried away by exhaust steam and radiation ..	470·0
		Converted into work on piston	23·1
	498		497·98

Of the 23·1 units of heat really converted into work on the piston, 4·8, or 21 per cent., are taken up by the weight of moving parts; and again 5·6 units, or 24·3 per cent., are afterwards lost on the cooling of the compressed air, leaving only 12·7 thermal units, or 1·2 per cent., of the refuse value in hand contained as energy in cold air at 100 lbs. pressure. The diagrams which here follow represent the foregoing analysis.

In conclusion, it is desirable to state that this trial is not by any means submitted as a model result, but simply to show what is at present going on at Royton. The authors do not for a moment suggest that the arrangements as described should be followed out by other engineers designing plant for the same purpose. If the results show anything at all, they show that the idea of burning town refuse at any sort of profit is erroneous. It cannot be imagined that refuse which gives on evaporation anything less than 2 or 3 lbs. of water per lb. of refuse would pay for carting. And what sort of refuse must that be? Certainly not the kind found in Lancashire; and if not there, where can it be found? In burning town refuse one labours under the disadvantages of—

1. A large percentage of moisture in the refuse;

2. The necessity of heating a large percentage of air in excess in order to get it to burn at all;

3. The loss of considerable heat in the abnormal quantity of ash produced.

The above results point to a calorific value of about 4000 thermal units to be possessed by town refuse containing the moisture which it usually does to bring about an evaporation of 2 lbs. of water, and any refuse containing this is practically only half-burnt coal.

If any economies are to be effected in the future in the utilisation of town refuse, the points towards which attention might be profitably concentrated are, as shown by the results here recorded:—

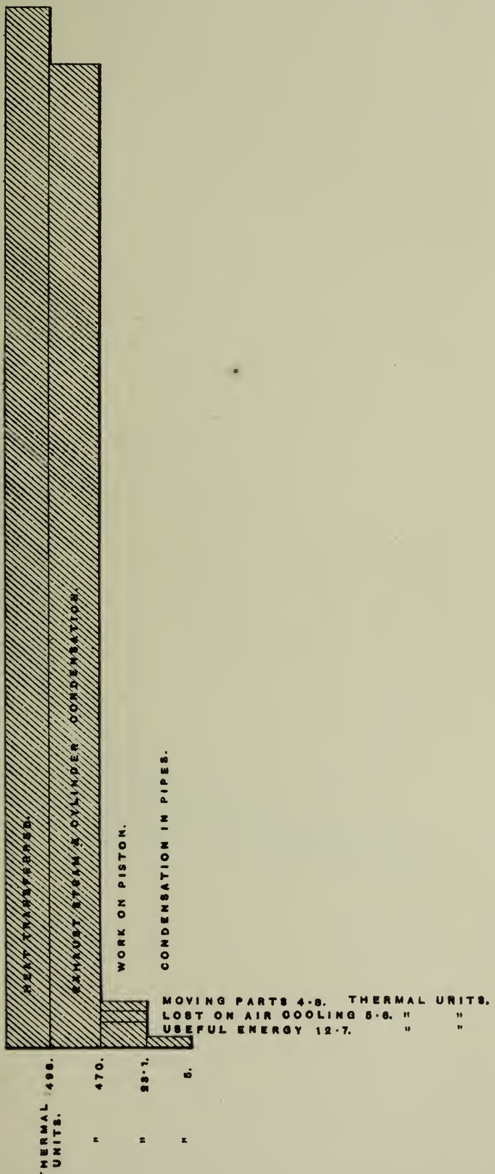
1. Reduction of loss of heat owing to evaporation of moisture contained in the refuse. Such reduction will probably be brought about by the utilisation of the exit gases for drying the refuse primarily.

2. Reduction of loss incurred by the heating of excess air. There is certainly no known probability of burning the refuse with a smaller quantity of air, but another mode of economical working is open, viz. that of abstracting from the excess air by means of economisers, some portion of that heat which at present it carries away.

But apart from the actual burning of the refuse, greater economies may surely be effected at sewage disposal works by the adoption of condensing steam engines, considering the low pressures used and the abundance of cooling water, and again by the retention of the partially exhausted air, which is at present blown to waste out of the sludge rams.

W. Naylor.

Royton Sewage Depôt.
Heat Transferred to Water, from 1℔ Refuse.



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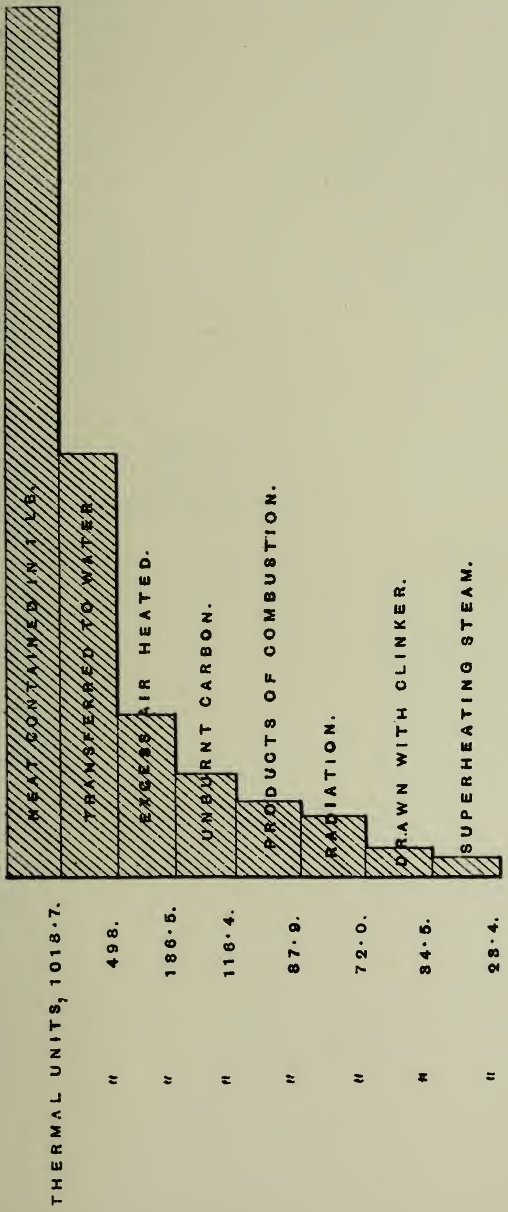
Royton Sewage Depôt.
Heat Disposal Diagram 1℔ Refuse.



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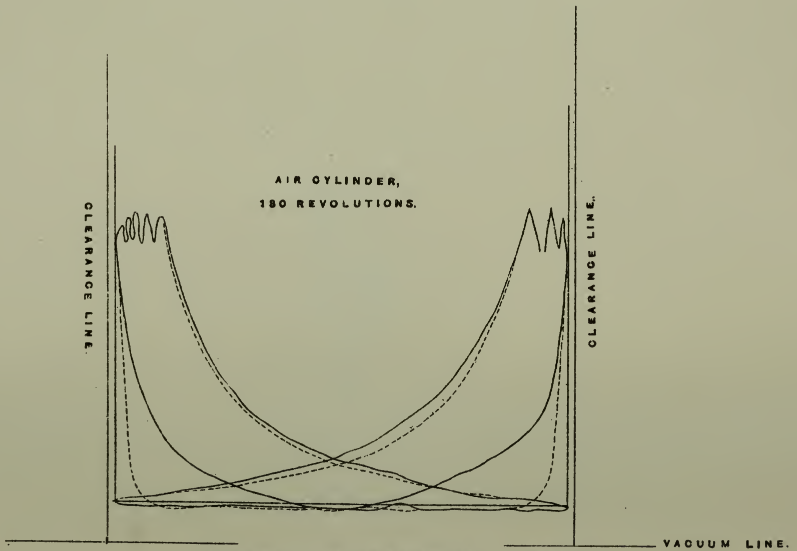
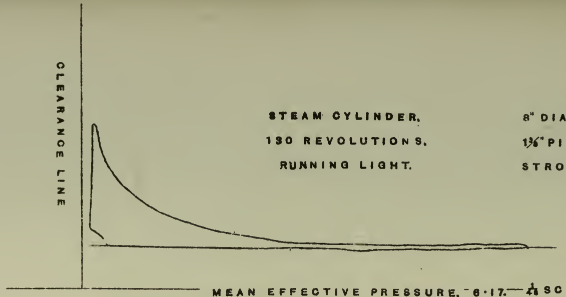
Royton Sewage Depôt.
Air Compressor Diagrams.



MEAN EFFECTIVE PRESSURE, 23·8. $\frac{1}{48}$ SCALE.

PISTON SPEED, 846·6. STROKE, 18". PISTON ROD 1⅜. CYLINDER 5½" DIAMETER.

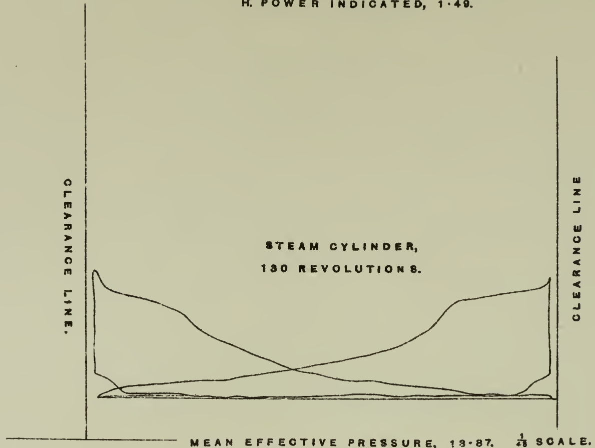
H. POWER INDICATED, 5·75.



STEAM CYLINDER.
130 REVOLUTIONS.
RUNNING LIGHT.

8" DIAMETER.
1⅜" PISTON & TAIL RODS.
STROKE, 16".   CLEARANCE ¼".

MEAN EFFECTIVE PRESSURE, 6·17. — 1/48 SCALE. —— VACUUM LINE
PISTON SPEED, 346·6.
H. POWER INDICATED, 1·49.



STEAM CYLINDER,
130 REVOLUTIONS.

MEAN EFFECTIVE PRESSURE, 13·87. 1/48 SCALE. —— VACUUM LINE
PISTON SPEED, 346·6.
H. POWER INDICATED, 7·10.

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DISCUSSION.

Mr. H. P. Boulnois: I have much pleasure in moving a vote of thanks to the writers of these papers. They contain a very valuable amount of information which will add materially to the usefulness of our minutes of Proceedings. I should like Mr. McCallum to tell us exactly where Royton is situated. We know it is in Lancashire, but we do not know its exact locality. The description of the works is valuable in being so much in detail, but I do not think there is any feature of novelty in the actual working, and the authors point out that they do not advise that the methods adopted at Royton should be adopted elsewhere. I notice on p. 244 that "the furnaces have sloping rocking bars, and are provided with steam jets, but it is not found necessary to use the latter." Turning to the other paper, we find that from the refuse no less than 46 per cent. of clinker is produced. Now, sir, that is a very large percentage indeed. Most of us know that the average amount of clinker is 25 to 33 per cent., and 46 per cent. is a large proportion, no doubt owing to very low combustion. The question is, whether the use of the steam blast would not add to the temperature and consequent combustion, and the residue left would be much less. The details of the cost are valuable to us. I notice in both the records that are kept, the cost of labour for the destruction of the ashpit refuse amounted to 10*d.* per ton. That is also rather high. I think for labour only it should not be more than 8*d.* per ton. At Liverpool I am able to destroy refuse in a 24-cell destructor at an average cost for labour only of 8½*d.* per ton. The paper bristles with figures which are, of course, impossible to follow after only having had the paper placed in one's hand for a few minutes, and it will be well that great care be taken in printing it for our Proceedings, to see that all the figures are correct. We have heard many alterations, many corrections, whilst the papers were being read. The temperature—going back for a moment—seemed very low indeed. On p. 249 Mr. Naylor states that the exit temperature of the flues was recorded at 356° F. only. Does he mean by the exit of the flue the base of the chimney after the gases have passed through the boiler, or what does he mean? On the same page I should like a further explanation as to the carbonic anhydride, the nitrogen and the excess air, which he gives in cubic feet. What does he mean by weight per pound of refuse worked out in decimals of pounds? Does he mean those gases are produced by that weight of refuse which he puts in line with the other figures? The table is not quite clear on that point. Then on p. 251, coming to the table there, the first item on the credit side, heat transferred to water: Does Mr. Naylor mean by that the water of evaporation of the refuse itself, or does he mean the heat transferred to the water in the boiler? The great value of this paper, to my mind, is that by very careful experiment Mr. Naylor has reduced the thermal value of the refuse, and on p. 253 he says that amounts practically to only 3·4 horse-power per hour per cell. We have taken it with our boiler at Liverpool, and find it gives 6 horse-power per hour per cell. No doubt, if the boilers were placed over the cells, a greater calorific value would be obtained out of the refuse consumed. The conclusions of the paper, giving the difficulties to be overcome and the economies which are to be practised in the future, are exceedingly good, and I think that probably this paper will lead to considerable discussion in the professional newspapers, on account of this question being so largely before us, as to what is actually the calorific value of the refuse of towns. Prof. Forbes has given us an exaggerated view of the value of refuse; this paper gives us the opposite view. But looking at the heats generated, I should say this destructor is not doing the work we should expect of it.

Mr. J. H. Cox: There are a few remarks I should like to make on this paper. I have had the privilege of visiting the Royton sewage works, and think them exceedingly well arranged. There are one or two points in the paper read by Mr. McCallum which appear to require explanation. It struck me that the working expenses seemed rather high. The cost is somewhat complicated by the destructor expenses being mixed with the expenses of sewage disposal, and after reckoning even 1*s.* a ton for the refuse dealt with, it would leave something like 30*l.*; then deducting another 7*l.* for the pressing of the sludge cake, it leaves 23*l.* for treating less than 7,000,000 gallons of sewage. I noticed the point Mr. Boulnois has referred to—viz. that steam jets are provided but not used. It seems to me a very serious mistake not to use them. The temperature of 356° is exceedingly low, and I should not expect a perfect combustion with such a low temperature. Before we began to work with steam jets at Bradford we had a temperature of about 500° and a very imperfect combustion. After we got a cremator we obtained much higher temperatures, and got rid of complaints of nuisance, and by the use of two steam jets to each cell we have obtained still higher temperatures, increased the horse-power from 6 to 16, and have been able to dispense with the use of the cremator except for a few hours at the beginning of each week. Even now we are not utilising all the heat. The temperature as it enters the chimney is frequently 1100° to 1200° F. The figures given in the paper as to the amount of horse-power which may be expected from a destructor worked by a forced draught are therefore somewhat misleading. As to the amount of water evaporated per pound of refuse, we get very nearly the same results at Bradford as are obtained by the author of the paper. Ours is ·52 lb. of water evaporated per pound of refuse; but the amount of moisture in the refuse to begin with is very much higher in our case. We have 46 per cent. instead of 23 per cent., as given in the paper. As regards the residue, the refuse, on being passed through the destructor, is reduced to one-third in weight and one-fourth in bulk. One remark as to heat lost by unburnt carbon in the clinker. Possibly, if greater temperatures were obtained, the clinker would be much freer of this unburnt carbon. As regards the sludge pressing, it makes one somewhat envious to find they can reduce the sludge-cake at Royton to under 50 per cent. of moisture. We are peculiarly placed in Bradford with respect to the amount of grease in the sludge, which prevents the water getting away freely when pressed. We cannot press the cake to contain less than 75 per cent. moisture, although I know it is usual to reduce it to about 50 per cent. I think the paper is a very valuable one, and I have very much pleasure in seconding the vote of thanks to the authors.

Mr. E. G. Mawbey: It gives me very much pleasure to support the vote of thanks to the authors of this paper. I think these gentlemen are to be highly congratulated upon the experiments they have made at Royton. Mr. Naylor's calculations—when we thoroughly understand them—should prove very valuable to us. I do not want to say anything now about having the papers in our hands a day or two before a meeting is held, but this is a paper in which it would have been a great advantage to every member desirous of taking part in the discussion. With regard to the water evaporated per pound of refuse, and horse-power per cell, it appears to me that uniformity of data is required. Take horse-power per cell. One engineer will allow a different quantity of water evaporated per horse-power to another. Therefore we ought to know how much water is allowed in the calculation. In

Leicester we carried out some experiments, and I found there we evaporated—burning 9 tons of refuse per cell per 24 hours—about one-fifth of a pound of water per pound of refuse. I think it comes out at 450 lbs. of water per ton of refuse. I worked that out, allowing 30 lbs. of water evaporated per horse-power, and that gives 5·6 horse-power per cell. That is nearer the mark, but that is beaten now in some destructors. We know we get more than that by getting more heating surface. The temperature of the escaping gases at Royton is very low. It points to this—either the heats have been taken out, or else the refuse is not properly burnt. In some of the destructors I have seen the refuse is rushed through; and under such working conditions it cannot be properly destroyed. We found by introducing the rocking bars we were able to raise our temperature up from 700 or 800 degrees to about 1800 degrees and more. We found our pyrometer would not register the heats obtained in the main flue with the rocking bars patented by Mr. Biddles, the foreman of our destructor works. Our refuse gives a residue of 25 per cent. of ashes and clinker, and we reckon that a fair amount to allow. Then another matter is the kind of refuse you have to deal with. In some places it is very wet, being collections from middens and ashpits, while in other towns the refuse is the collection from portable bins. All sorts of conditions have to be considered in estimating the results of different towns.

With regard to Mr. McCallum's paper, I think it is a very valuable contribution. I have carried out some experiments with polarite filters at Leicester, and obtained some very excellent results, but it may be useful to the Members to give them the results of my experience in one respect. I have found that you must keep lime out of polarite filters. The polarite gets choked up with carbonate of lime and is rendered useless. We found we must not send the effluent through the polarite in an alkaline condition, but that it must be neutral or only slightly acid. I think my predecessor, Mr. Gordon, was the one who really brought these results out. He at first got some very wonderful results, but on my going to Leicester I found I could do no good with the filters he had been experimenting with. On looking into this I found that the polarite was choked up with carbonate of lime caused by an alkaline effluent having been sent through.

Mr. W. Spinks: Like other speakers I have not had sufficient time to go thoroughly into the results of the experiments given in the paper. But being in Halifax, which has become famous for experiments with destructors, of which we hear very little just now, it has occurred to me that we might have some information given us as to those experiments. My friend Mr. Jones and myself attended a series of meetings in Westminster last autumn, at which one of the speakers assured us most solemnly that they had at Halifax evaporated rather over 5 lbs. of water per pound of refuse burnt. We worked this out, and we found it came to about 11 lbs. on the combustible material (deducting the clinker and moisture), which is rather better than the best Welsh coal. That was such a startling statement that we were compelled to ask whether the experiments had been made with Silkstone or Denaby Main coal or town refuse combined with tar. Possibly, being in Halifax, we may hear something more about it. Then, with regard to the amount of clinker: I quite agree that the amount stated by Mr. Naylor is excessively high. At the Congress of the Sanitary Institute at Liverpool Mr. Button stated that in the experiments he made at Warrington he only got 17 per cent., and the Leeds experiment showed only 25 per cent. I should think Mr. Boulnois is perfectly safe when he puts the clinker at 25 to 33 per cent. But, as Mr. Mawbey says, the results want comparing very carefully side by side, taking into consideration the material to be destroyed. You cannot compare the results of a Lancashire town which has to deal with midden refuse combined with ashes, with the dry refuse of a town which has a water-carriage system of sewage. Then we ought to know the system of combustion. They vary very much according to whether the steam blast is used, or the Meldrum system, or the Warrington system, or the Manlove, Alliott & Fryer system. And the results want comparing side by side before we can apply them to our own district.

Mr. C. Jones: Mr. Spinks has referred to some results which were gone into at Westminster. They were certainly very surprising. I will not attempt to explain them in any way; it is for those who produced to explain them, if they are able to do so. It is very difficult after having the paper before you for only a few minutes to discuss it, more especially as some of the figures are admitted to be wrong and misleading. There are certain points which have already been referred to, and I should certainly like to emphasise the remarks made by Mr. Boulnois as to the low exit record of 356° F. I should very much like to have information as to the character of the refuse dealt with. This is a matter of very great interest to us, for it is one of the questions of the day; and we want to form our opinion upon data as to which there can be no doubt. We have to deal with refuse of a different class, and it is very important that we should have a definite principle to act upon in making comparisons of results. Take my own experience at Ealing; I put in the rocking bars referred to by Mr. Mawbey, and I found they are of no value to me. The rocking bars created an inconvenience rather than conferred a benefit; but that might not occur in another place where the material to be dealt with is of a different character. So in comparing a Lancashire town with a southern town you must take into consideration that there is a different class of refuse to be consumed. It is upon these points that we want data in comparing one set of results with another, and to arrive at a safe comparison upon which we can work. I confess I do not understand Mr. Naylor's statement on p. 248 of the paper as to heat lost. It may be my want of comprehension, but I do not see my way clear to understanding it, and I do not know whether I am right in the conclusions I have drawn from the statements. Mr. Naylor says the clinker is allowed to lie in the ashpit until it has fallen to a temperature of only 500 degrees F. Now what was the maximum temperature reached in the cells? It would be interesting to know, because upon that depends the correctness of the statement as to the quantity of the residuum which is left. The details as to the heats attained are so conflicting that I think there must be some error. I should say that the heat in the cells must have reached 700° or 800° if the clinker had to lie in the ashpit until it reached 500°; and with cells working up to a temperature of 700° to 800° there ought not to be so large a residuum. That is my opinion from the result of many years' practical working.

Valuable as this paper is, it wants to be carefully canvassed, and I would suggest that it be revised and notes added, so that when we get it in our Proceedings we may look upon it as a reliable record of the working at Royton. This is becoming a "burning" question all over the country, and it is well that we should have some record of which we can say, "I know this by practical experience. These data are correct, because I worked them out and found them to be true."

Mr. J. P. **Barber**: The amount of clinker is undoubtedly high, and I should like to have, as a supplement to the paper, information as to the kind of refuse dealt with. Clearly it cannot have been ashbin refuse as we understand it in the south. I imagine it would be ashpit or midden refuse of the north, containing a good deal of moisture and material which is not combustible, because we should be able to get a much better result from the refuse from an ashbin, as distinguished from an ashpit town. I have roughly worked out the quantity per cell per 24 hours, and find it to be just over five tons. That certainly ought to have given a much greater horse-power than was arrived at in this experiment. But at the same time I would point out that the experiment was only conducted during a period of 5¼ hours. I think experiments such as this are apt to be misleading. We don't want to know what would be done in 5¼ hours, but what is the calorific value of the refuse collected in a town for a period of six or twelve months. That will give us a better idea of the calorific value of the refuse we have to deal with. The calorific value of this refuse must have been very low indeed. Then the temperature of the gases seems to be exceedingly low; that has already been remarked upon. But what I cannot understand is, how the clinker is allowed to remain in the ashpit until it has fallen to 500°, if the gases in the cell where these clinkers are heated are not more than 360°. If the material sinks to 500° in the ashpit, it must have had a much higher temperature in the cell, and the gases must have been much higher than 500°. Perhaps the author will tell us if the temperatures of the gases were taken at the base of the chimney, after they had passed the boiler. Mr. Naylor says, "If the results show anything at all, they show that the idea of burning town refuse at any sort of profit is erroneous. It cannot be imagined that refuse which gives on evaporation anything less than two or three lbs. of water per lb. of refuse would pay for carting. And what sort of refuse must that be?" Certainly it would not be profitable to burn town refuse if it had to be carted solely for its value as fuel. But we must pay for it to be carted or barged into the country, or use it for filling up low places, or burn it. It is not for profit that we burn refuse, but with the idea of utilising this offensive stuff, and disposing of it in the most economical manner. If we can consume it, and by utilising the large amount of heat resulting from its combustion for producing steam, reduce the cost of dealing with the refuse, then I think it is certainly an economy to burn it in destructor cells.

Mr. E. J. Silcock: I should like Mr. McCallum to give us some information as to the system of sewerage at Royton, so that we can form some idea of the quantity of sewage which comes down in wet weather. The quantity is put down at 180,000 gallons a day in dry weather, and for that quantity, the tank capacity seems very large. I should like just for a moment to refer to the heat lost by the drawing of the clinker. It seems a very problematical matter as to the heat lost going back to the furnace. The radiation of heat is going out in all directions, and a good deal of it would go to the front of the boiler house.

Mr. H. Dearden: I wish to draw attention to this house refuse burning, as more a sanitary than a money-making matter. Taking this view I am certainly of opinion that any temperature less than 1800 degrees of heat will not by any means render this rubbish innocuous. The clinker coming from it will not be safe to be buried in any place where buildings will be erected, and if it is destroyed with any less heat it will be a means of creating a nuisance. If the heat is not sufficient to destroy the gases and the germs of disease in the rubbish, it is valueless. We must inform our Corporations that the primary thing is to destroy the rubbish thoroughly. That is a matter we ought not to lose sight of, and the cost must be a secondary matter.

The President: Before I call upon the authors to reply, I will ask you to accord them a hearty vote of thanks.

The vote of thanks having been unanimously accorded,

Mr. W. Naylor, in reply, said: I wish to thank you for the very courteous manner in which the paper has been received. I must first explain that the gases were drawn and the temperatures registered after passing the boiler on the way to the chimney, so that the temperature of 356° is not by any means the highest temperature to which the gases were raised. It is only the temperature after a very large proportion of heat had been transferred to the water in the boiler. The temperatures were taken by a pyrometer, and indicated 1250° F. in the furnace and 1800° F. at the cremator. I did not see my way to insert this in the paper, as that is only the calorific intensity, and has no direct bearing on the calculations. Mr. Jones thinks there is an error somewhere, and does not say where; but I can assure him there is not. It has been suggested that it would have been better to have given the temperature of the clinker as it fell, but what does this matter? The only point which concerns us is the temperature at which it was put in the furnace and at which it was carted away. All the other heat has gone up into the furnace. It does not matter so long as we know how much heat has gone up the flue, what the actual initial and final temperatures were. It has been suggested that the heat may have radiated away from the ash and not gone up the flue. But at the particular point at which it was put there was a tremendous draught towards the furnace. I cannot think there is an error of 1 per cent. in the heat which went away from that clinker lying under the furnace bars. Mr. Boulnois, like every one else, thinks there is some mistake in the percentage of ash. I must confess there is a very high percentage of ash, and there are some uncommon items in the paper. They would not be in the paper if they were not uncommon. The 40 per cent. of ash includes all the ash, both the clinker, the fine ash and the flue ash weighed in. There are causes which tend to make the ash higher than the average. A very poor coal is used, which has been struck off the Admiralty list after tests made on its behalf, and further, it is a very poor working class neighbourhood, the average rateable value being exceedingly low, and the cinders in every house are riddled two or three times, so that the refuse is burnt as far as it is possible to burn it in ordinary cottage grates. That is the percentage of ash both by analysis and weight, and no amount of steam jets will burn ash properly.

Mr. Boulnois: What I think the meeting want to understand is this—that ash from a domestic fireplace of this particular coal, if burnt under a strong steam blast to a white heat, will give a residuum of 46 per cent. If experiment has shown that, I have nothing to say.

Mr. Naylor: The ash you speak of is primarily a cinder. The ash I am speaking of is what you term the residuum.

Mr. Mawbey: At one time we only got about 1200° or 1400°, and when we got our heats to 1800° or 2000° we got a smaller proportion of clinker.

Mr. Naylor: The only way to know whether the application of a steam jet would reduce the amount of residuum is to make an actual analysis of the residuum and see what is there to burn. That was done at Royton with an oxyhydrogen jet, and it was found that the unburnt carbon in the ash was 1·8 per cent. only. That is about the average amount when the percentage of carbon is higher to begin with, as in good steam coal for example. If you can reduce that, where it is an amount worth talking about, I admit that by every pound of carbon so consumed you reduce a like amount of weighed out ash. I have not expressed my opinion as to the advisability of using a steam blast. But at Royton it is not very desirable, for many reasons. It is necessary to bear in mind that when sufficient steam is decomposed to liberate 1 lb. of hydrogen, it requires just as much heat to decompose the steam as that pound of hydrogen gives out on burning, so that the only advantage to be gained by the use of a steam jet is the amount of air entrained with the steam and thrust, so to speak, on the burning refuse. The result will be that more refuse may be burnt in a given time, and also a reduction made in the amount of unburnt carbon; but at Royton the furnaces will get through more refuse than the district provides, and generate more steam than the compressor requires without a steam jet. I quite agree with Mr. Mawbey that the indicated horse-power per cell depends upon conditions which vary in different towns. It depends upon the calorific value of the refuse dry, the amount of water evaporated per pound of refuse, upon the condensation in the steam pipes, and upon the condensation in the steam cylinder. I think it was Mr. Spinks who said that 5 lbs. of water per pound of refuse had been evaporated in Halifax. I can hardly credit that from common refuse. I have tested slacks, and only got 3 or 3½ lbs.

Mr. Spinks: It is not my statement. It is a statement of Mr. Cheesewright.

Mr. Naylor: Some gentleman remarked that the author of the paper supposes that refuse is burnt for a profit. I have not supposed anything of the kind. But as Halifax was the seat of the trial where attempt was made to burn refuse for profit, I thought this was a good opportunity for showing it to be erroneous, as far at any rate as one district is concerned.

Mr. McCallum, in reply, said: I join with Mr. Naylor in thanking you for the courteous way in which the paper has been received. I may say, in reply to Mr. Boulnois, that Royton is near Oldham, in Lancashire. With regard to the working expenses being high, the instructions of the Council were to have everything in first class order, and not to skip anything to keep the expenses low. In answer to Mr. Silcock, I may say it is not the separate system, and we have a good deal of storm water to deal with in the case of storms.

SEWAGE FARM MANAGEMENT.

By Lieut.-Col. ALFRED S. JONES, Assoc. M. Inst. C.E.

Only last autumn the author of this paper brought this subject before the Sanitary Congress at Liverpool, and its importance is so fully recognised by all experts that he feels that an apology is required for his present effort to move the Association to some practical action with a view to correct the mismanagement of sewage farms, which has become so apparent of late years.

Our Members may with justice plead that their pressing duties in many other directions make it impossible for them to influence individually the management of a special technical art carried on in the country by a shifting committee of their Sanitary Authority.

But they cannot shut their eyes to the sanitary and financial mistakes which are now common in many parts of the kingdom, and it may be possible for our Association to act *collectively* for the information and guidance of all who are responsible in such matters.

The irrigation of land with more or less impure water has been practised in all countries from time immemorial, and is carried out to perfection in hot, dry countries, like Egypt and India, with cheap labour, to great profit; but its success is everywhere dependent on the sufficiency and intelligence of labour employed for regulating supply of water and removing crops at the right moment.

Self-interest has educated the labourer and owner wherever local conditions and engineering art afford reasonable prospect of continuous and large profit, such as that reaped for centuries from the Craigentinny Meadows, near Edinburgh.

But when we began to realise the fact that land and plant life are the only purifiers of town sewage, it was thought that the supply of educated labour would not fail for the right disposal of sewage, even where the prospect of profit was less evident or altogether absent, and that it only remained for the engineer to convey sewage to a level or evenly sloping surface outside the town, laid out with carriers, and to leave an ordinary farm bailiff to distribute the liquid at discretion.

The consequence has often been that this inexperienced farmer has tried to grow crops in the ordinary manner and let his sewage as much alone as the committee would allow, with result that this body come to the conclusion that he is sacrificing the purification of sewage to the interests of his crops, and order him to turn the sewage here and there without regard to growing crops; and a sewage marsh discredits the whole principle of sewage farming.

Public opinion revolts from the subject, and opens a willing ear to any new inventor who promises to put the difficulty out of mind by some short cut of his own, the latest dodge being always the most popular, although a quarter of a century's experience of hundreds of patents leaves the Native Guano Company's practice more successful than any of its rivals in the only result attainable without land, i. e. clarification.

Success of this kind, moreover, is also a question of educated labour, and the old-established company now dealing with the sewage of Kingston-on-Thames are happy in the possession of a staff of men who, by long practice, can perform the scavenger sort of work necessary to effect separation of the sludge and to turn the clarified effluent into a tidal river with the requisite cleanliness of works to satisfy visitors on a show day and to earn the company's subsidy.

In the same way with organised labour in scraping solids from iron gratings to burn by destructors, and transporting wet sludge in tank steamers to the Nore, a system has been established by Mr. Crimp, C.E., and Mr. Dibdin, chemist to the London County Council, which has materially reduced the nuisance formerly created by the discharge of crude sewage at Barking and Crossness.

Now it seems remarkable that the limited work of clarification should have interest enough to attract the thought and attention required to attain such results, but should interest no one where the question of purification is concerned and thought and attention are required in a much higher degree. There are exceptions, of course, like Birmingham, Nottingham and Wimbledon, where really skilled managers are well supported by wealthy corporations, and carry out the work of purification satisfactorily, though always hampered by too large a proportion of sewage to acreage; but on smaller farms, with more favourable conditions as to area, false economy and inefficient results, both sanitary and financial, are generally admitted.

An impression has got abroad that the expenditure on sewage farms does not pay, and should be cut down as much as possible. While this false notion prevails there can be no hope of improvement; for weeds will grow if useful crops are not cultivated, and there is no return whatever for the cost of removing the former, while the proverbial "sewage marsh" is the necessary result of pouring sewage on to a growing crop of either kind. Thus arises the temptation to limit the area of land and keep it always fallow; but, as the Massachusetts experiments with very weak sewage have shown, land even specially prepared as a filter-bed soon gets clogged, and nitrification ceases until the filter-bed is re-made or its power restored by the growth of a crop.

Experience teaches that nitrification is the work of an air-breathing microbe on or near the surface, and that plant life uses up the organic matter thus prepared with extreme rapidity if the supply of sewage is intermittent.

Now it is the business of the sewage farmer to get his crops off as fast as they grow, because the land is wanted for more sewage, which it ought never to get, except in the early stages of the crop's growth. He has to bear in mind that the stream of sewage is always coming, and arrange that a sufficient area of his land shall be fallow in winter, or occupied in summer, by young crop, in order that he may have room to spread the liquid intermittingly at all times for sanitary reasons; and simple as this appears, it is found difficult in practice, because the weather is so uncertain in our climate, and no hard and fast rules can be laid down. Watchfulness on the part of the manager and his watermen is the essential quality when it is a question of sending off the best possible effluent, and those who understand their business know that good heavy crops are the best factors in transmuting sewage into such effluent.

Consequently a large gross return follows, as a matter of course, a good effluent, and those ignorant people who talk of sewage farms being misapplied by sanitary considerations being postponed to the interest of their cropping are doing much harm by discouraging their manager's efforts to attain a double success in effluent and crop, which simply cannot be separated and obtained in either without the other following as a matter of course.

Gross return in crops, let it be understood, is all that is above referred to, but the grower will soon see it his interest to have as little weeds as possible in the bulk, and to dispose of it in the best available market; that is a farmer's business not likely to be neglected by any one who has had the intelligence necessary to attain the double success by the only means available for either.

This good economical result as rent or profit on the farm balance-sheet is, however, not attainable in the first or any given year, owing to the large labour expenses which must be incurred with the double success, and farming committees and their managers have not strength of character or fixity of tenure sufficient for reliance on the *average* result in rent and profit over a series of years;—that has been the real bane of our sewage farming in England.

For in numerous instances it has led to starvation in labour and the growth of ordinary bulk of crops with a bad effluent, and often to the destruction of much of the poor crops by untimely doses of sewage in emergencies which have not been foreseen, as well as to nuisance from stagnant sewage and foul effluent.

We have introduced this new mode of sewage farming all over the country without a model farm or any provision for the technical education of managers, and cannot be surprised that ordinary farm labourers have not yet risen to the occasion immediately on appointment as managers under a committee of town tradesmen whose views are generally bounded by the next council election.

The farms have generally been started, after long expensive contests with landowners, overburdened by capital outlay which has all been spent before any thought was given to the floating farming capital necessary to its proper working, and it is the general idea of the council to cut down the bailiff's salary and all outgoings to the average rate per acre of a neighbouring farm labour bill.

Under such circumstances is it likely that three or four times the weight of crops grown on such neighbouring farm will be grown on the sewage one thus crippled? The bailiff's natural course is to get rid of as much sewage as he can into the nearest watercourse or by evaporation, and to do the best he can to persuade his committee to give him labour enough to deal somehow with the fertility in weed, &c., forced upon him by the remainder of the sewage.

And when nitrification is suspended over much of his land from stagnation of sewage he asks for additional land only to spread the nuisances of such mismanagement over a larger area.

The most bitter opponent of sewage farming, it may be said, could not draw a worse picture; but however much the author believes in irrigation as the right means of sewage disposal, he cannot shut his eyes to common instances of mismanagement, and he knows that they may at any time be put right when public opinion realises the facts above stated, and insists on sewage farms being worked at high pressure, with the double object of pure effluent and large crops.

It may seem absurd to enunciate once more truths set forth by Royal Commission judges and practical farmers so often before, but though familiar to our Members, they are not sufficiently recognised by local authorities and public opinion, which those authorities must have at their back before they can authorise proper outlay on labour.

It seems strange that so many millions of borrowed capital should have been expended on sewage farms after public inquiries in all parts of the country, and no further questions asked by the Local Government Board or other authority as to the working of those farms during the last twenty years; but such is the fact if we except the action of the Royal Agricultural Society of England in 1879 into the working of a limited number of sewage farms.

Agricultural depression may account for a good deal of the lethargy and indifference in this special branch, but sanitary considerations should have prevailed over the fear of low prices and made up for the latter by increased crops instead of by reducing labour.

The author can count on his fingers the self-educated sewage farm managers who do justice to their charge, and knows that if any authority requires such a manager he is rarely to be found. He has consequently suggested technical education at model sewage farms for managers and watermen, where a register of qualified persons could be maintained.

But the first and all-important measure for improving sewage farm management is to enlighten the public as to existing evils and to excite general interest in their abatement; and it occurs to the writer that a deputation from our Association jointly with Members of the Institution of Civil Engineers to wait upon some

Member of the Government might have a good effect in drawing attention to the matter.

While writing this paper the author was called upon by the War Department to undertake the management and reform of their camp farm at Aldershot, which has fallen into great disgrace of late years.

This was a compliment which he would have accepted more warmly if it had been offered some five years ago, when he was shaking off his old harness at Wrexham, and when the state of things at Aldershot had not reached the present low ebb.

But he knew this camp farm in its prosperous days, under the management of Mr. James Blackburn, and after preaching as he has been doing lately, he could hardly refuse this call to assist in restoring its credit, if possible.

The emergency was very pressing, for the War Department had given notice to their tenant to quit on the 20th instant, and their new manager will take over its charge on that date with no light heart, but in the earnest hope that, in spite of old age, he may yet be able to do something more to prove in practice what are the sanitary and economical advantages of distributing town sewage over suitable land.

DISCUSSION.

Mr. R. Godfrey: I have taken particular pains to look at the point Col. Jones raises in his paper. It is one I have had the pleasure of discussing with him, that is, the education and training of sewage farm managers. I think the suggestion is one worthy of consideration, and one which it might be advantageous to this Association to consider, whether in these days of technical education and scientific knowledge there should be some technical education for farm managers. A man may be a very good agriculturist, yet when put upon a sewage farm he is completely beaten. I simply make these remarks to open the discussion. I hope other Members will follow it up.

The President: I think Mr. Godfrey has put the object of this paper very clearly before us, viz. that a sewage farm manager should have some technical knowledge of the duties which he has to carry out. I should like to propose a vote of thanks to Colonel Jones for his kindness in sending this paper, and to express our regret that he is not here to enforce what he says upon the meeting.

Mr. W. H. White: I have great pleasure in seconding the proposition. I quite agree with the remarks that fell from Mr. Godfrey, and there is no doubt that Colonel Jones has hit a very bad blot in farm management. In Colonel Jones' absence I do not see that there is anything to gain in discussing the paper. I take it we are all in favour of the views he enunciates.

PARK AND GARDEN ARCHITECTURE.

By THOMAS H. MAWSON, Garden Architect,
Windermere.

Garden making has been said to be the only art in which the realisation surpasses in beauty the original conception. However this may be, it is true that unlooked-for suggestions and combinations of beauty arise at every stage of the work, each year's growth bringing new revelations of charming groupings of foliage and lawn. A sarcastic critic, seizing upon this idea, said that the art of landscape gardening relied chiefly upon accident for its effect.

In order that indefiniteness in this paper may be avoided it was thought advisable to head it 'Park and Garden Architecture,' by which it was intended to imply that design must everywhere be apparent, and that little or nothing should be left to accident.

Landscape Gardeners, Old and New.

Considering the immense possibilities open to those who undertake to lay out parks and gardens, very little, if any, advance has been made in the art of garden and park making. The cause of this is not far to seek ; we have only to go back to the early Georgian period, when, influenced by the low ideals in art and literature of the day, men turned their backs upon the good old examples of heroic efforts and grand aims, and ran after what they considered a new discovery, which was briefly that every bit of pastoral scenery was of itself a garden fair. Ignorant indeed, and blind also, must these men have been not to have seen that the old garden designers were worshippers of nature as well as they, and that they brought to nature's shrine a cultured reverence to which they were entire strangers.

Yet so it was, and thus we find that for the future imitation took the place of exalted idealisation, the crudest forms in nature being placed upon a higher pedestal than the sweetest forms repurified by man's imagination. That some corrective to the vagaries into which the old school had fallen was required is indeed true, but such a radical change as that brought about by the landscape gardeners of the latter part of last and the beginning of this century is to be deplored. Many of these were men whose abilities were measured by the amount of deception they were able to perpetrate. With such ideals it is not surprising that sham castellated ruins and other absurd excrescences came to be considered as necessary adjuncts to garden scenery.

It was during this depraved period that public gardens and parks began to be more generally recognised as a public need, and, taken as a whole, the parks then made show how low art had fallen. Emancipation from these misconceived methods may be slow, but improvement in some direction is now called for; it is, in fact, necessary to make parks and gardens more worthy of the name, by introducing more of the method and spirit pursued in the days when the best English art work was produced, when the architect designed anything, from a door knocker to a garden, when the garden was looked upon as a pure invention, and not simply as a piece of wild nature transplanted, not in reality, but in caricature, without rhyme or reason. In a park or garden invention and intention should once more be made apparent; it should be a place where the wealth that produced it should not be altogether lost sight of; its beauty, and ornamentation, should be according to man's conception and forethought.

On Idealism in the Park.

Some explanation of what is really meant by idealism in the garden and park may be advisable. Well, it is simply man's conception of beauty expressed in wood, stone, tree, shrub, greensward, and gravel walk—the happy union of things which are allowable, because they are necessary, useful, or agreeable in themselves, arranged so as to form a pleasing whole. As J. D. Sedding happily expresses it, "It is man's report of earth at her best, man's love of loveliness carried to excess, his craving for the ideal grown to a fine lunacy."

Compare the modern park, with its curling walks and drives leading to nowhere, its lakes in all sorts of apparently unnatural and impossible situations, cast-iron fountains, band-stand, and even grandfathers' clocks of the same material, unlovely girder bridges, little mountains, and miniature Alps, its assortments of rockery stones, arranged like so many gravestones, weak and sickly conifers sadly proclaiming their alienship; compare all this with the stately avenues, grand parterres, quiet alleys, shady walks, sparkling fountains, and all the various associations of the old work, and you get some idea of the gulf which separates the two schools of landscape gardening, the new and the old.

Of course the requirements of the public park to-day are not the same as those which had to be incorporated in the old gardens, but the spirit which actuated these old designers might be imported into the modern work, and so make our parks in some reasonable degree on a level with our boasted modern art culture.

To attain to the excellence of this old work it is necessary that everything, small or great, be designed in harmony; that everything, whether building, planting trees, shrubs, expanse of water, grass lawns, &c., be designed or planned with due consideration to its fitness, proportion, and balance, without incongruity or discord. To attain this completeness and unity of the whole implies that to a knowledge of architecture, the chief essential, must be added a study of the technics of good gardening and of arboriculture.

The true park must, like most other inventions, rest on the foundation of good planning, worked according to whatever characteristic is to have predominance, whether seclusion or recreation, or an equal combination of both. On level ground it is comparatively easy to shut off the various recreation grounds into proper compartments, the eye never being high enough to obtain a panoramic view, but in dealing with a site with considerably varying levels much would depend upon the disposal of these features. The trampled grass of the cricket crease, the cinder path of the cycling course, and the noise of the excited footballers, are disturbing elements which require careful handling, but, as a rule, everything which is calculated to induce physical recreation should receive careful attention. The requirements of the surrounding population would, of course, decide what to go in for, but the following are specially worthy of consideration:—Lake for boating and bathing ponds; children's playground; cycling tracks; football grounds; cricket creases; bowling greens; archery courts; quoit grounds; gymnasiums for both sexes; tennis lawns.

East End Park, Wolverhampton: a Typical Site.

As an example of a typical site for a modern park, the site of the East End Park, Wolverhampton, is a good specimen, well calculated to suit the requirements of the surrounding population. The sum, however, to be spent on the formation was so small that to the south of the terrace nothing beyond flooding for a lake and the formation of walks through the hollows and masses of foliage on the rising ground could be attempted. Here the outline of lake was decided by the natural contour of the ground. To the north side of lake, and nearly in the centre of the park, was arranged the promenade, in connection with which was the refreshment and shelter pavilion, flower garden, fountain, and terrace walks. To the front of terrace a balustraded wall with steps leading down to a broad boat landing. From the centre was arranged a bridge, connecting an island with the main terrace. Upon this island it was proposed to erect the bandstand. The terrace is reached from the north by an avenue, which is connected to the main entrances by a segmental road, leaving a good space for children's playground; to the right and left of this avenue are arranged the various recreation grounds. The football, quoits, and gymnasium grounds are reached by separate postern gateways from the boundary road, as also the children's playground, thus obviating a number of aimless walks and the crowding of the park proper with noisy youths.

The Same Site, but with Formal Design.

The recreation grounds may be very little altered, and the lake, to save cost, left practically the same (though it might be more in keeping with a formal scheme of this kind to arrange the water line in some geometrical form). In place of the curves are straight walks and avenues. Clipped hedges are freely introduced for secluding geometrical gardens. There are bowers and wide borders for roses and old-fashioned plants, banks of rhododendrons and choice flowering evergreen shrubs. The positions of the two side entrances are altered so as to give directness to the wide walks; to the island is given an architectural aspect. The terrace walls are finished by two temples or pavilions, under which are boat-houses. The recreation grounds are completely shut off by holly hedges, and a winter garden is attached to the pavilion. This second plan professes to be in every particular, except the latter, a purely artificial arrangement.

From these plans it will be seen how necessary it is that every arrangement should be complete as a whole, and have some underlying principle running through the entire scheme; that the designer of the pavilion and central features should arrange the perspective of the avenue leading up to it, should arrange the expanse of unbroken lawn and sheets of water, and place the displays of colour; that the designer knows where intricacy or simplicity are needed, where to dispose and group the plantations for shade, seclusion, or to form vistas, how to adjust the high lights of fountain spray, and the requisite amount of importance to give to each of the entrances.

On Ornamentation.

Although too much stress cannot be laid upon the planning or framework of the public park, to clothe and adorn with beauty each respective part, and still preserve the unity of the whole through all details with thorough completeness is

> "Taste's important task."

To accomplish this in any degree worthy of the end in view we must study and idealise nature, and not choose the detail from the ironfounders' catalogue. Ruskin says, "The man who has an eye to nature will invent beautiful proportions, and cannot help it." Whilst, however, this is true, we must not forget to saturate our minds with the teaching of bygone and contemporary art workers.

In the public park there are so many things upon which the beautiful may be expressed that the eye may be instructed and pleased at every turn. Take, for instance, the boundary fence; why always adopt an unbroken line of unclimbable spiked heads? An equally cheap fence can be made by introducing wrought-iron panels at intervals, and by other devices. Again, wrought-iron or oak entrance gates, of simple design, are more artistic than more elaborate cast-iron ones; a simple brick or stone pier is also preferable to the lamp-post kind of pillar so often met with. The shapes into which the hedges should be cut and the arrangement of flower gardens are also worthy of a little extra thought. The band-stand, the "temple of music," is upon this account worthy of more becoming artistic treatment and better material than is usually bestowed upon it. Then, again, there are the fountains, drinking-fountains, terrace-walls, flower vases, and garden seats, &c., all of which may be so designed "that the sight of them may contribute to man's mental health, power and pleasure." In the purely horticultural and arboricultural part there are numerous inducements to bring out pretty ideas and devices in flower-bed, gravel, and greensward.

The Natural Park.

It is not herein purposed to condemn entirely landscape gardening as at present practised, but to advocate more the judicious selection and association of the forms of nature, and to dispose them according to artistic conception ; this is quite another thing to slavishly copying nature. Here the whole skill of the nature-lover finds pleasure in turning her weakness into strength, and her crudeness into grace. Then there is the touching up of nature, or helping nature to speak the truth. This is a phase of park designing which always requires careful thought, as nearly every site possesses different natural features ; let us say a small stream, not much naturally, but which deftly touched up here and there, can be made "a joy for ever." There may also be a few loose masses of scrubwood looking disconnected and unsociable which require sorting and pruning, and the insertion of a few Lombardy poplars and thorns to break the skyline, and a few groups of wood anemone, daffodils or wild hyacinths distributed about, and it becomes one of the most delightful spots in the park.

There may be cases in which the foregoing touching-up principle is the only possible one to adopt, but even here it is to a great extent possible to keep clear of the make-believes which characterise some park-makers' work. Take a case in point, say a piece of land, 60 acres in extent, mostly old pastures and meadows divided by hedgerows in which there are a few old trees, the land for the most part of very undulating character, a stream running through the ground, the soil fairly good, ranging from black to brown loam, lying on marly clay; the ground largely surrounded by factories and coalpits, the atmosphere for a town fairly clear.

The requirements are—

1. Lodge and two main entrances, and two foot entrances.
2. Lake as large as possible for boating.
3. Cricket ground.
4. Tennis lawns and bowling greens.
5. Main drive.
6. Ample walks and roads for promenading.

The sum to be expended, 6000*l.*, inclusive of keeper's lodge and boundary fence.

The total sum to maintain annually not to exceed 500*l.*, half of which is to be supplied out of the rates, the remainder to be raised in revenues from the park in boat hire, &c.

For a proper practical working of the site an accurately surveyed contour plan should be made, the contour lines being given, say every 2 feet. On this plan should be marked the positions of the entrances; these would be decided by the importance and direction of the surrounding roads and streets.

A safe estimate for the erection of the park-keeper's lodge and entrance, with the additional entrance, would be 1000*l.*; the fencing would probably not be less than 1000*l.*, and the two smaller entrances 250*l.*, leaving 3750*l.* to expend upon laying out the park.

One of the most important things in the laying out of a park of this description, especially in a populous neighbourhood, is to obtain as large a lake as possible. After testing the ground to see if it will hold water, a blue line should be run round the contour line up to the level to which it is safe to flood; the result would be a perfectly natural outline, as at Thirlmere Lake after raising of water level. It would require an area of not less than 12,000 yards super of gravel walks and spaces, which estimated at 2*s.* 6*d.* per yard, exclusive of excavation, would cost not less than 1500*l.* Then there is the cricket crease. If more than one site suggest themselves, select the one nearest the boundary road, so as to allow of a separate entrance. The same should be done in respect to the children's playground, but choosing the most populous side of the park. Tennis lawns and bowling greens can be located anywhere, as they are not disturbing elements in any park.

The next point to be considered is how and where to run the walks and drives. The first question is, where is it most desirable to go to? There is the lake; there will be certain pleasing views it will be desirable to pass; the various recreation grounds must be reached somehow. There is a dell here and a copse there for quiet byepaths, and it should be the endeavour so far as possible to connect the whole together without destroying the natural contours or features of the land, avoiding all deep cuttings and high embankments, thus emphasising the varying levels of the land. In so doing you will find yourselves skirting round that hill and through this hollow with a series of curves which are natural. They are the lines which the farmer's carts took when carting manure on to the land, and along which the sheep made tracks, but, unlike the latter, making walks on the sides of steep banks should be avoided. The main drive should have something of directness about it, and not be less than 20 feet in width.

Of ground work there would be as little as possible; the drives and walks would make some little cutting and filling necessary to bring down to verge lines. These verges would be connected to the general slopes, not by batters, but by graceful curves, always leaving a flat verge on each side of the walk of not less than 3 feet.

At the point of outlet from the lake the natural mounds at each side would be helped by being made as narrow as possible, and a waterfall either architecturally treated, or by groups of boulders and large quarried stones arranged in stratifications. In grubbing hedges the finer trees and thorns might be left. To the east, or from whichever quarter the winds of the district were most prevalent, the planting should be dense, preferably of Scotch fir, if it would grow. The sides bounded by factories and mines would require tall growing trees to block out these surroundings and to give an aspect of quietude to the park; this latter idea might be further assisted by hiding the boundaries. At other places where the traffic was likely to be great, the sides of the hills would be planted with masses of native trees, such as beech, elm, sycamore, chestnut, cherry, crab, thorn, with undergrowth of common holly, yew, elder, dogwood, mahonia and privet. In the dells or in places where not too prominent, groups of rhododendrons might be introduced. The lake margin would be planted at intervals with masses of silver-leaved and other willows, alders, &c.; wild-flowers would also be freely scattered about. To increase the revenue, parts might be pastured with sheep or cattle, the drive being first railed off and the plantations protected.

If after this there was 400*l.* or 500*l.* to spare, it could be expended on a simply designed erection placed at a point convenient to the lake and drive, and towards the centre of the park if possible. This could serve the purpose of refreshment room, rain shelter, cloak room, with conveniences. If possible to fill the other conditions, the building might be placed on the edge of the lake and serve also as a boat-house.

In such a park as the one just described, everything of a cast-iron or tin tabernacle nature should be avoided. There would be no bedding out or display of foreign shrubs of the monkey-puzzler order, nor would there be any notices warning people to keep off the grass; every pleasing natural feature would be retained, but its picturesqueness enhanced wherever possible, and everything unsightly blocked out and hidden.

In the foregoing we have the two ideas which are possible without violating the canons of good taste: "the first is made on purpose to please," the second is nature's work adapted to the requirements of man with as little interference as possible.

ON COMPROMISES.

It is quite possible to imagine some Parks Committee saying, "We like the stateliness of your ideal park, but we have taken such a fancy to the natural park that we cannot give it up entirely. Why not compromise matters? We do not mind spending another 3000*l.*, which will allow of a lot of polishing up; we would also like a fountain and band-stand included, and some flower-beds certainly." Compromises of this sort generally produce mediocrity or something worse; the rich embellishments of the stately garden making profane love to the simple, comely graces of nature, to the loss of self-respect which should characterise each. Far better than this amalgamation, set aside some portion of the ground for design proper, and have some clear line of demarcation between the enclosed garden and the natural park.

In such a park the designed portions would include a terrace, or formal garden, which would generally have the same relation to the park as a country house and gardens have to the home park. This elevated terrace, occupying a position commanding the finest views, should be easily reached from the main entrance, preferably by an avenue, and the slope to the lower portions of ground arranged into a series of levels reached by broad flights of steps, and it would be a pleasing arrangement if the lowest flights of steps opened on to the lake.

On one of the terraces, probably on the highest, might be erected a pavilion, with refreshment rooms, conveniences, and cloak rooms; on a second terrace, the band-stand. The whole of the terraces would most properly be supported by a balustraded wall, and would be laid out with broad gravel walks of not less than 10 feet wide, and large plots of grass, out of which a few flower-beds might be cut. At the foot of each terrace wall there would be wide borders of old-fashioned perennials, and up the walls would be trained climbing roses, choice clematis and jessamine; to each side would be gardens and courts, surrounded by holly, yew, or cypress hedges, clipped into shapes, flower-beds edged with box, stone or terra-cotta, centralised with a fountain or sun-dial. There would be plenty of opportunity for the display of rhododendrons, azaleas, and choice shrubs. These gardens would be so placed as to be easily and conveniently reached from all parts of the park.

Such a compromise would probably please most people; it should however, be borne in mind that the success of such a scheme would need a fortunate and appropriate site.

The Landscape Park.

Much has been said and written about merging the formal and natural styles by easy and imperceptible gradations. This is a principle which has had such worthy exponents as Repton, Loudon, Paxton, Marnock, Milner, Kemp, Sir Charles Barry and Thomas, all of whom have left good examples of work of this kind. The objections to it have already been given, but there are instances where its adoption was advisable. A similar instance occurred at Hanley Park, which is some 80 acres in extent. Very little of the ground was in its natural state, being partly covered by pit mounds, refuse from ironworks, brick-fields and potteries. A canal cuts through the centre by an irregular line. The ground falls considerably to the south, the atmosphere is heavily charged with chemicals and smoke, which are very injurious to tree growth, thus rendering it impossible to attempt anything in the shape of clipped hedges.

None of the land was to be pastured; a lake had to be made, a pavilion provided, and also ample terraces for promenading; the sites for these latter were arranged at a point commanding the only distant views of a pleasing character, and overlooking the whole park, south of the canal. Viewed from this point, the balustraded terrace wall makes a fitting foreground, whilst the pavilion and terraces form a central feature to lead up to. In the plantations only a few varieties of trees could be used, and these, to give any effect, required to be planted in considerable masses. How the merging is done is explained by the general plan and section. It should be explained that the straight walk and avenue alongside of canal is a deviation from the general plan for the purpose of illustration; the cost of this would put it out of all question. From these drawings it will be seen that under very adverse circumstances some attempt has been made to realise idealisation of detail; whether or not it will prove successful, remains to be seen.

A Few Practical Suggestions.

Before finishing this paper, a few general suggestions of a practical nature, and also a few hints as to what to specially avoid, may help its usefulness.

Small gardens and open spaces should invariably be treated in an architectural and formal manner; quietness of style should be their chief characteristic.

In small parks of five to ten acres, fountains and architecturally treated ponds may often be worked in with good effect. A wealth of flowers arranged in formal beds is always appreciated in small parks. Lawn-tennis courts and bowling greens, within quaintly clipped hedges, always look well. Colonnades, parterres, avenues of pollarded limes, give grateful shade. All walks should be broad, especially on terraces, never less than 10 feet on a terrace, and promenade walks never less than 20 feet. Shelters and band-stands should be specially designed to harmonise with other features in the park; high keeping and primness should always be associated with small parks.

As a rule, parks and gardens of 10 to 20 acres should not be cut up by drives, especially if in a district with a large working-class population.

Parks of this size are generally expensive luxuries, as they are too small to allow of much space being allotted to recreation, such as children's playgrounds or football grounds, without destroying its quietude; neither can any portion be laid off for pasturage, consequently all the ground requires to be kept up; but where cost of keeping up is not taken as a very serious matter, and if the neighbourhood be favourable to plant life, it is a size which lends itself to variety of treatment. It is large enough to accommodate all sorts of good gardening, including fine terraces and parterres, rose bowers and gardens, gardens for American plants, and rock gardens for Alpines, ponds for aquatics, shady borders for ferns and lily of the valley. There is also space for fanciful alleys and colonnades, and for avenues, for bowling greens and lawn-tennis creases. In such a park a large conservatory or winter garden would add very much to its attractions. This should be designed so as to accommodate as large a number of persons as possible during the show season. A park chrysanthemum show should be arranged for every park. The conservatory designed for the West End Park, Wolverhampton, is a good form of plan for a public park.

Fine broad avenues are always appreciated. For this purpose limes, planes, elms, beech or sycamore are the best; the width of an avenue should never be less than 45 feet, and the trees should never be planted closer than 35 feet apart. Avenues should always be straight.

In very large parks and on level ground a very pleasing effect may be made by planting three rows of trees to either side, the first, thorn; the second, wild cherry; the third, planes or sycamores.

For terrace slopes a batter to meet a step with 6 inch rise and a 14-inch tread is a very good one. Steep slopes burn very quickly; formal lines should never merge into natural slopes, a definite break of some kind should always be made between the two.

Things to Avoid.

Of the things to specially avoid, the following are very important:—

In designing.—Unreality and pretence.

In planning.—Narrow walks and drives. On level ground, serpentine lines; on undulating ground, lines which do not express the contours. Main walks which do not suggest directness and a study of the public convenience; the arrangement of football grounds in the centre of a park, unless the park is of considerable size.

In architecture.—All appearances of jerry in construction, and veneer in ornament, spiked hurdle or barbed wire fences, cast-iron gates and pillars, lodges copied from the "Architecture made easy" books, stock pattern band-stands, fountains and vases, conservatories which appear to be built entirely of glass, rustic wood bridges and summer-houses, ornamentally designed and conspicuously placed cast-iron urinals, and, generally speaking, stock pattern anything.

In landscape formation.—Bad drainage; in trenching, the bringing of subsoil to surface; in formation of beds for plantations, less than 1½ foot of soil; slopes which rise or fall immediately from the edges of drives or walks; white spar rockwork. Where it is necessary to introduce rockwork, a professional rockbuilder should always be employed.

In planting.—Narrow belts; dotting of single trees, especially small growing conifers on lawns; small specky plantations; a too free use of ornamental conifers and evergreens to the exclusion of hardwoods; avenues which have a variety of trees in the same line.

Generally.—Flower-beds around the bases of trees or plantations, clipping trees and shrubs with shears, excepting where formalism is required.

CONCLUSION.

Most of the foregoing suggestions have been urged time and again by the writer when dealing with Parks Committees or Corporations, but in reply it has very generally been stated that the views here expressed show too great a confidence in the art perception and good feeling of those who generally patronise public parks, such replies being very often backed up by numerous instances of destruction, especially of verges and lawns, and in other cases of trees and flowers. So firmly have some Committees been impressed with this idea that it has led to all sorts of bad arrangements in parks with which the writer has had to do. At Wolverhampton, for instance, a walk is to follow the margin of the lake, because of a fear lest any turf or plantations which ran down to the water's edge should be destroyed. After considerable study of the subject, the writer has come to the conclusion that the public value most things in proportion to the amount of earnest work put into them by the designer and craftsmen working under him. Where destruction takes place it is very often, "though not, of course, always," because the thing destroyed had little right to exist, or otherwise because the planning was so bad that destruction was but the natural sequence.

TRADE EFFLUENTS.

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At a district meeting of this Association, held at Nottingham on 29th April, 1892, the Borough Engineer, Mr. A. Brown, M.I.C.E., in his paper referred at some length to the steps that were being taken in Nottingham to cope with the very serious nuisance caused by the discharge of manufacturing refuse into the river Leen, and explained at some length the course it was proposed to adopt.* Since that time, owing to the action of the Mersey and Irwell Joint Committee in the watersheds of the rivers under their jurisdiction, and also to the action of the West Riding of Yorkshire Rivers Board, the question of purifying trade effluents has aroused some considerable interest in the manufacturing centres of the North, and the author being engaged in preparing a number of sewerage schemes where the difficulties have to be faced, it has occurred to him that an interchange of opinion and experience by the Members of this Association cannot fail to be of advantage to the community at large.

The author does not propose to lay before you any particular methods of dealing with trade effluents *per se*, but rather to submit some considerations in those cases where they do discharge into existing sewers, or where it may be desired that they should discharge into any contemplated system of new sewers; and the first point that presents itself is, what rights have manufacturers to have their effluents connected with public sewers? Many of them, by long user, have acquired a prescriptive right, but the bulk of them, no doubt, will be governed by existing legislation—which, to say the least of it, is delightfully vague.

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* See vol. xviii. pp. 125-132.

LEGISLATION.

The special clause dealing with manufacturers' refuse is sec. 7 of the Rivers Pollution Prevention Act, 1876, which reads as follows :—

"7. Every sanitary or local authority having sewers under their control, shall give facilities for enabling manufacturers within their districts to carry the liquid proceeding from their factories or manufacturing processes into such sewers.

"Provided that this section shall not extend to compel any sanitary or other local authority to admit into their sewers any liquid which would prejudicially affect such sewers, or the disposal by sole application to land or otherwise of the sewage matter conveyed along such sewers, or which would from its temperature or otherwise be injurious in a sanitary point of view.

"Provided also that no sanitary authority shall be required to give such facilities as aforesaid where the sewers of such authority are only sufficient for requirements of their district, nor where such facilities would interfere with any order of any court of competent jurisdiction respecting the sewage of such authority."

This section has been incorporated in the West Riding of Yorkshire Rivers Act, 1894.

So far as the author is aware, there has never been any decision by the courts under this section by which any hard and fast lines can be laid down for the guidance of all parties concerned, so that it would appear, therefore, that the question just rests where it did; but those districts that have adopted Part III. of the Public Health Amendment Act, 1890, have a little more controlling power under sections 16 and 17, which read as follows :—

"16. (1) It shall not be lawful for any person to throw, or suffer to be thrown, or to pass into any sewer of a local authority or any drain communicating therewith, any matter or substance by which the free flow of the sewage or surface or storm water may be interfered with, or by which any such sewer or drain may be injured.

"(2) Every person offending against this enactment shall be liable to a penalty not exceeding ten pounds, and to a daily penalty not exceeding twenty shillings.

"17. (1) Every person who turns or permits to enter into any sewer of a local authority or any drain communicating therewith

(*a*) Any chemical refuse;

(*b*) Any waste steam, condensing water, heated water, or other liquid (such water or other liquid being of a higher temperature than one hundred and ten degrees Fahrenheit) which either alone or in combination with the sewage causes a nuisance or is dangerous or injurious to health :

shall be liable to a penalty not exceeding ten pounds, and to a daily penalty not exceeding (£5) five pounds."

The law being as it is, therefore, we must do the best we can with the conditions that present themselves to us. First of all we must make quite sure in formulating any new scheme of sewerage what are sewers and what streams. In many places watercourses have from time to time been culverted, and to them have been connected, besides wastes from manufactories, drains from houses. During 1894 proceedings were taken by the Mersey and Irwell Joint Committee, under the powers of their Act of 1892 (ch. cxci.), against a manufacturer for polluting a stream, when it was proved in evidence that the stream was culverted, and that it received the sewage from two or more houses, and it was therefore held on appeal at Quarter Sessions that it was a sewer as defined by the Public Health Act, 1875, and that the proceedings should have been instituted against the sanitary authority. This decision is of importance to all authorities and their engineers.

Quantity of Effluents.

The quantity of domestic sewage is variable according to the class of property in the district to be sewered and the habits of the population, and varies from 10 to 40 gallons per head per day, and the maximum quantity discharged at any given period of the day can be approximately ascertained, but not so the quantities of trade effluents. In making the necessary inquiries to ascertain these, innumerable difficulties present themselves to the engineer—excepting, of course, in those cases where all the water used is drawn from the public supply and is passed through a meter—as it seldom happens that any intelligent gaugings have ever been taken or recorded of the water passed away; at any rate, not in a sufficiently minute or accurate manner to be of any assistance to the calculations of the engineer, who must know approximately not only the daily and nightly discharge for each day of the week, but also the maximum discharge and the times and duration of the periods of such abnormal flows. The control of the water supply and wastes in most manufactories is generally left to some millwright or foreman, who on being interrogated generally replies "that he has either so many taps running for so many hours here, or there so many pipes emptying certain reservoirs at such and such times, or else a pump which works for so many hours from a well of a known depth, and from these very vague figures, perhaps multiplied many times over the district, an engineer is expected to base his calculations, not only for the discharges of his sewers and for the capacity of his tanks or filters, but also for the process of treatment for the sewage and sludge. It is hardly necessary to point out how, under such circumstances, impossible it is in the case of a pumping scheme to definitely fix the quantity to be lifted and the power to be provided. The same considerations also will affect the selection of positions for storm overflows and the height of their sills.

In preparing any new scheme it is quite impossible to gauge the measure of the requirements that will be caused by future extensions. Loans for sewerage works are granted for 30 years, and it is to be supposed that the sewers will suffice for that period of time, but when once you decide to admit trade effluents, you will become the slave of the fluctuations in the state of trade, and whenever the good times return and works are extended and multiplied, then the existing sewers would utterly fail to meet the new exactions made upon them. The magnitude of this portion of the question will be understood when you learn that an ordinary sized bleach or calico printing works disperses each working day 500,000 gallons of effluent water.

RIPARIAN RIGHTS.

Many trades, such as those referred to, are generally carried on by the bank of some stream which is usually dammed up at some convenient point above the works; and the water led by a head goyt into a settling reserve, thence to be drawn as required. It is quite clear, therefore, that all such water after use must be returned to the stream direct, and that if it was discharged into any sewer and carried down to the outfall works, certain premises lower down stream on the route of the sewer would be deprived of the enjoyment of this quantity of water in carrying on their trade. The author is acquainted with land laid out for manufactories on the sides of streams where due provision by means of weirs and goyts has been made for supplying water, and he considers that it would be most injudicious in such cases to admit from premises above, effluent water primarily taken from the stream, and carried along the sewer past such sites.

Composition of Trade Effluents.

The composition of ordinary sewage is well known, and Dr. Burghardt, in his paper at the Annual Meeting at Bury, gave us his description of it,* and in the West Riding of Yorkshire River Act, 1894, s. 3, it is defined as follows:—

"Liquid sewage includes unpurified urine, excrementitious matter, and liquid refuse of any house or premises, blood and the washings of a slaughter-house containing blood or urinary or fæcal matter, but does not include any liquid rendered poisonous, noxious, or polluting in the course of some manufacturing process."

The detailed analysis of domestic sewage as ascertained by the Rivers Pollution Commission in 1868, is given in the following table:—

Table I.—Average Composition of Sewage.

In Parts per 100,000.

Description.	Total Solid Matters in Solution.	Organic Carbon.	Organic Nitrogen.	Ammonia.	Total Combined Nitrogen.	Chlorine.	Suspended Matters.		
							Mineral.	Organic.	Total.
Midden towns	82·4	4·181	1·975	5·435	6·451	11·54	17·81	21·30	39·11
Water closet towns ..	72·2	4·696	2·205	6·703	7·728	10·66	24·18	20·51	44·69
In Grains per Gallon.									
Midden towns	57·68	2·926	1·382	3·804	4·515	8·078	12·467	14·910	27·377
Water closet towns ..	50·54	3·287	1·543	4·692	5·410	7·462	16·926	14·357	31·283

Domestic sewage is never very variable in its constitution, but if trade effluents are added there will be noticed during its flow striking changes, both in its colour and in its odour, according to the kind of waste discharged from the manufactories. In places where the textile, tinctorial and chemical trades are carried on, we find sulphuric, hydrochloric and nitric acids, alkalies, soap lees, solutions of iron, zinc, tin, alum, copper, chrome, antimony and arsenic, waste dye liquors, spent dye wares, glue, sizes, dressings, lint, fleece, fibre and waste tan solutions. In districts where hardware, iron wire and kindred trades are prevalent, we find the sewage holding in solution iron in considerable amount, derived, e. g. from "pickling" iron wire, also containing salts of iron as ferrous chloride.

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* See vol. xviii. p. 306.

By way of comparison, the author places side by side the analysis of eight samples of Littleboro' sewage and of Salford sewage; the former may be taken as a fair type of the sewage ordinarily met with in small towns in Lancashire, Yorkshire and Cheshire, while the sewage of Salford, as is well known, contains a large proportion of trade effluents, and the whole compound is about as vile as it is possible to imagine.

ANALYSIS OF LITTLEBORO' SEWAGE, containing no trade effluents.

ANALYSIS OF SALFORD SEWAGE, containing trade effluents.

All in parts per 100,000 gallons.

Date.	Albuminoid Ammonia.	Oxygen in 4 hrs.	Albuminoid Ammonia.	Oxygen in 3 hrs.	Date.
1894					1891
Dec. 26	0·192	1·017	0·50	..	July 7
„ 27	0·367	3·173	0·90	3·271	„ 8
„ 28	0·455	2·899	1·00	2·20	„ 9
„ 29	0·350	3·138	0·90	7·90	„ 10
„ 31	0·437	3·066	0·80	8·308	„ 11
1895					
Jan. 2	0·367	3·372	0·59	4·26	„ 23
„ 3	0·385	3·549	0·50	2·7	„ 30
„ 4	0·525	4·362	0·30	4·0	30 and 31 (night)
Average ..	0·384	3·097	0·71	4·663	

The analyses of the Littleboro' sewage are of the mean of hourly samples.

In the immediate district of Halifax the trade effluent is chiefly from wool-washing operations and dyeing, and the sewage, after receiving them, changes from hour to hour, and sometimes has basic and sometimes acid characteristics, and there is a continual alteration of the sewage with regard to its permanent alkalinity. Where trade effluents are discharged into the sewers it is essential, if the process of treatment is to have justice done to it, that manufacturers must treat the sanitary authorities fairly, and must discharge their effluents equally, as far as possible, and not hoard up their strongest liquor for despatch during the night or on Sundays, unless they are desirous of the authorities coming within the clutches of the Rivers Boards, which is an experience more honoured in the breach than the observance.

Treatment of Combined Sewage.

The question of the treatment of combined sewage is essentially one to be settled by chemists and bacteriologists, leaving the engineer to design the necessary works requisite for the process. The borough engineer of Nottingham, in the paper previously referred to, gave us the results of his considerations, stating that "he had come to the conclusion that it was quite as difficult to clarify and purify bleach and dye water as it is sewage," and he also detailed some experiments made in applying some of the mixed sewage on the Nottingham Farm in the following manner:—

"In order to thoroughly test whether the chlorinated lime and other chemicals would have any deleterious effect upon the crops when combined with sewage, some interesting experiments were made. A quantity of average bleach and dye water was carted down to the farm, and after being diluted with twice its volume of ordinary sewage, the combined liquids were used on certain areas, and the effect upon the crops carefully noted and compared with similar crops treated with ordinary sewage only. The result of these experiments showed that there was actually no difference at all in the crops, and that the crops treated with sewage plus bleach and dye waters, throve just as well as those treated with ordinary sewage only;" and in concluding his remarks stated: "That where a sewage farm is already available and in working order, the most economical method of treating and purifying these waters is to combine them with the ordinary sewage, and purify by broad irrigation."

It would be interesting to know now, after a lapse of three years, what has been the result of this treatment, because within three months of the reading of that paper another was read before the Association in which such a system was sweepingly condemned by Dr. Burghardt,* and more recently (24th May 1894) Prof. Dewar, in giving evidence on the proposed scheme for Bradford at the Local Government Board's inquiry held by Mr. Arnold Taylor, said: "The land never would discharge the functions usual to land in any way, simply because it would be clogged with fatty matters. The fatty matter resisted change, and simply killed the land. The fact was it was simply impracticable to apply it directly to land."

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* See vol. xviii. pp. 307, 8, 9.

It would, perhaps, be as well to explain the character of Bradford sewage, and, according to Prof. Dewar, "The wool-washing product was by far the most serious element in the Bradford sewage—firstly, because there was a very large quantity of solid matter in suspension, which came from the crude material in the fleece, and secondly, from the fact that there was in it a large quantity of alkali, which was required to remove fatty matters. As they would be well aware, the fat of the wool was of a very different character altogether from ordinary fatty material; it was a substance which they knew in the purified state now as lanoline, and which had the remarkable property of adhesion to water. This caused very great difficulty in getting any mechanical separation of it from the sewage. It was not like ordinary fats, which would rise to the surface. If one had an alkaline liquor, and then neutralised it, ordinary fats would rise rapidly, as oil or other solid materials, which one could freely skim off. But this wool fat produced an emulsion which took a long time to settle. Very minute microscopic globules were formed really in suspension, and these were exceedingly difficult to separate. The usual mode in which this was done was either by allowing it a long time to settle, or by using a centrifugal separator, which separated very readily the coagulations of minute particles of fat. This, therefore, indirectly modified the whole character of the precipitating process. The fatty material was really merely removed by adhesion to any oxide or other form of precipitant which was used for ordinary purification of sewage, and the consequence was that it was removed, though it did not, strictly speaking, combine with the oxide."

Upon Prof. Dewar's advice, extensive experiments on a large scale in precipitation and filtration were carried out at Bradford, so as not to rely on mere laboratory experiments alone, and "it was found impossible to have anything like a satisfactory precipitation of the materials in suspension, and to get a fair, clear and good effluent, unless with the expenditure of an abnormally large amount of chemicals quite out of all proportion to that used in any other town. It was not a question of 8 or 10 grains per gallon, but one of adding as much as 50 or 60 grains."

Subsequently filtration was tried, after precipitation by oxide of iron and alumina, one filter being made of clinkers and the other of sand, used at the same rate as for water filtration, and it appeared that very little benefit was derived from the working of either filter. Prof. Dewar stated that, "Starting with three grains per gallon of matter in suspension, it was reduced by filtration through sand to one grain, but as regarded the character of the organic constituents, there was practically no variance. So there had been very little oxidation even with this slow rate of filtration. As far as the organic constituents were concerned, the liquor was just as good before as after the filtration. This was easily explained when one considered the character of the liquor which was being filtered, because the efficiency of sand filtration was largely due to the growth of minute organisms on the surface of the filters. No filtration did anything else but alter the appearance of the water."

Finally, as a result of these experiments, Prof. Dewar came to the conclusion that as filtration did not improve the water organically, the most efficient method of treatment was by extensive precipitation.

At the Annual Meeting held at West Bromwich, in July 1893, Mr. Pickering read a short paper on the "Sewage Difficulties in Nuneaton," * which was a very interesting account of the difficulties that had for years been met with in dealing with a sewage containing about two-thirds of trade effluent of an extremely obnoxious character. It would appear that the treatment finally adopted is almost identically on the lines of Prof. Dewar's suggestions, as the tank accommodation is about equal to the daily flow of the mixed sewage. The sludge, too, is shown to amount to about three times the quantity normally created by such a population, but, contrary to Prof. Dewar's opinion, there seems to be a value in it, as it is readily disposed of to farmers. It must be confessed, however, in spite of the great expense incurred in treatment, that the resultant effluent, as expressed in the analysis in terms of albuminoid ammonia, does not show a high standard, and indeed is such a one as would not successfully pass an inspection of the Mersey and Irwell Joint Committee.

It seems to be clear, therefore, that in dealing with combined sewage the engineer will be called upon to provide ample tank

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* Vol. xix. pp. 271 *et seq.*

accommodation, and how to determine their capacity is likely to baffle his ingenuity, owing to the difficulties, as has already been pointed out, in ascertaining the daily flow for any constant period. Nor will his troubles end here, for the sludge bogey is sure to arise, with all its perplexities increased in a manifold degree, and we have already been told that such sludge has chemically no value; then, in the words of Bulwer Lytton, "What will he do with it?" It is not every one who is in the happy position of our friend from Ealing, who, in the author's view, has reached the only satisfactory solution, and one which we must all copy sooner or later, perhaps the sooner the better.

Views of the Local Government Board.

It is now well known that, for the purposes of sewage purification, the Local Government Board insist that there shall be, as a minimum for filtration purposes, one acre of land to every 2000 persons, their opinion being that at present there is not a testimony sufficiently unanimous as to the efficacy of any other system of purifying sewage, and it is to be assumed that these figures have been decided upon for the treatment of ordinary domestic sewage, as their recorded opinion is against the taking of large quantities of trade effluents into the sewers so as to be dealt with jointly. This opinion, it will be noticed, was delivered rather later than one month after the holding of the Bradford inquiry, and referred to an intended scheme for Elland, which is situate on the river Calder, about three miles below Halifax, where Mr. Malcolm Paterson, M.I.C.E., proposed, in addition to the sewage from 10,000 persons, to provide for the taking in and treating of trade effluents, which he fixed at 500,000 gallons per day, these trade effluents being almost entirely from wool washing, dying, &c. After the inquiry had been held by the Local Government Board Inspector, the following letter was in due course received by the Urban District Council from the Local Government Board.

Local Government Board, Whitehall, S.W.,
June 28th, 1894.

With regard to the proposed works of sewerage and sewage disposal, the Board observes that, in addition to the ordinary domestic sewage, estimated at 20 gallons per head of the population, it is proposed to receive into the sewers trade refuse from manufactories, estimated at 50 gallons per head. The Board are advised, however, by their chief engineering inspector that this course is very undesirable, as the reception into their sewers of such large quantities of refuse, the character of which will vary from hour to hour according to the number of factories which are discharging their refuse at any time, will render almost impossible the proper purification of the sewage at the outfall, and the treatment which may be successful for this purpose at one time may utterly fail at another. The Board would therefore suggest that the Local Board should consider the desirability of taking steps to prevent the discharge of unpurified trade refuse into the sewers.—I am, sir, your obedient servant, C. N. Dalton, *Assistant Secretary.*

At the Local Government Board inquiry into the Brighouse sewerage scheme, held yesterday, the engineer, our Past President Mr. Fowler, stated that in addition to the sewage from 22,500 persons, calculated at 15½ gallons, he proposed to take and deal with the trade effluents, which he estimated at 9½ gallons per head per day.

The Inspector, Major-General Crozier, R.E., stated that the Corporation could not take an unlimited quantity of waste water and trade effluents. The available land at the outfall works, probably about 35 acres, would be completely drowned if they did not put a limit on this point.

Conclusion.

The author is aware that feeling runs rather high in many districts upon the equity of levying rates upon the manufacturers for the purposes of sewerage and sewage disposal works when they are not permitted to avail themselves of such sewers and works, but are called upon to expend their own capital in providing plant for treating the effluents upon their own premises. The whole question is a very delicate one, and this is hardly the place or the occasion to discuss it, the parties to determine it being the communities affected and the sanitary authorities, as engineering does not enter into this stage; but before any change can take effect it appears clear that alterations will have to be brought about in the existing laws, both as to rating and river pollution, and this will necessarily be a very slow business in the present state of the Parliamentary workshop.

There is just one other feature that must not be lost sight of, and that is the constant changes which are being brought about by new discoveries in the chemical and mechanical sciences affecting the processes carried on in the various industries, and which are all tending to lessen the obnoxiousness of the polluting effluent, and often result in discovering elements of value in the bye-products which render their recovery simple and profitable. This is an important factor for every sanitary authority to weigh when considering this question, as after providing ample sewer accommodation and extensive works, such discoveries might lead to alterations in the process of manufacture, entailing the withdrawal from the sewers of these effluents; hence a large capital expended would be lying comparatively unproductive, the interest on which would remain a charge on the rates until the term of years for which the loan had been granted had expired.

From whichever point of view we approach this question, it is sufficiently clear that in the present state of our knowledge no hard-and-fast lines can be laid down as applicable universally, but rather are we forced to the conclusion that each particular case must be dealt with on its merits, and that each special feature must be carefully sifted and considered.

The author ventures to think that before either sanitary authorities or their engineers can commit themselves finally to the adoption of the policy of taking in trade effluents, a great deal more exact information must be obtained than is at present ordinarily available, both as to the quantities and their constitution as well as the possibilities of change in the manufacturing process and subsequent treatment. He humbly submits that the subject affords a fertile field for research, and it is only by such patient labour that a reliable solution can be found. Possibly, as the outcome of our proceedings this day, some steps may be taken that will devise some machinery for setting about such investigations.

From time to time this Association, through the contributions of its Members, has presented to the world the various developments in the evolution of sewage treatment, and the author ventures to suggest that both to sanitary authorities and to their engineers no contribution will be of greater value than one affording a reliable solution of this important and prominent question which he has been permitted to present to you.

THE HALIFAX WATERWORKS.

By J. A. PASKIN, M. Inst. C.E.,
Waterworks Engineer to the Halifax Corporation.

The Halifax Waterworks were first authorised by the Act of 1762, and in 1848 came into the hands of the Corporation. They then consisted of a supply from springs adjacent to the town—Well Head, Birk's Hall Wood and Dodgson Clough springs collected in small reservoirs. In 1853 an Act was obtained and authorised what is known as the Ogden and Luddenden schemes. The Ogden scheme was first carried out, and gave the town a supply equal to 1,500,000 gallons per day. The Luddenden scheme was delayed until 1863, and gave an additional 1,500,000 gallons. In 1868 increased powers were obtained for constructing reservoirs in the Widdop and Walshaw valleys. The Widdop scheme has been carried out with an additional supply of 2,500,000 gallons per day, or a total of 5,500,000 gallons per day. There still remains the Walshaw scheme, which will give an additional 2,500,000 gallons.

The waterworks derive their supply from five separate valleys—the Hebble, the Luddenden, the Widdop, the Greave and the Walshaw Dean. The Ogden Reservoir is constructed on the Hebble stream, receives the drainage of 1140 acres, and holds 221,806,000 gallons of water, of which 990,000 gallons are daily discharged down the stream for the use of the mills. Leaving the reservoir, the conduit for conveying the water to Halifax passes through Mixenden, where another reservoir is constructed, receiving 190 acres of drainage of its own, but deriving its main supply from the overplus at Ogden. The capacity of the Mixenden reservoir is 106,122,000 gallons. The conduit passes in a tunnel under Mount Tabor, and empties itself into Ramsden Wood reservoir. This reservoir holds 11,700,000 gallons. The conduit then proceeds, in part tunnel and part ordinary cutting, to the Albert and Victoria reservoirs, which are the service reservoirs of the town, and from whence the piping commences and traverses the various streets and districts of supply.

The Warley Moor or Fly, the Upper Dean Head, and the Lower Dean Head reservoirs are constructed on the Luddenden brook. The Fly reservoir contains 193,251,000 gallons, has a drainage area of 919 acres, and is situated at a level of 1350 feet above the sea. Compensation water has to be discharged from this reservoir into the millowners' reservoir at Cold Edge, which is at a high level.

The Upper and Lower Dean Head reservoirs are constructed lower down the valley, near to Castle Carr, and have ornamental basins, &c. They contain together 122,155,000 gallons, and have a drainage of 525 acres. The compensation water to the Luddenden Mills amounts to 1,440,000 gallons per day. This quantity is chiefly discharged from Warley Moor or Fly reservoir. The conduit from these reservoirs passes down the Luddenden valley parallel with the stream, crosses above Catty Well and below Wainstalls, then enters the tunnel under Mount Tabor at Shaw Booth, and so into the Ramsden Wood reservoir, at which point it joins the Ogden system. This conduit, before leaving the Castle Carr valley on its road, receives Stony Spot spring and Shore End Wood or Back Clough springs, which are piped across the valley at a point near Lee Bridge.

The Widdop reservoir is constructed on the Widdop stream, and also receives by means of a tunnel the waters of the Greave valley, so that there is one reservoir for the combined drainage of two valleys. Their drainage is 2223 acres; the reservoir contains 640,311,000 gallons. The amount of compensation from this district to the mills is 1,620,000 gallons per day. From the reservoir the water is discharged into iron pipes, then into a tunnel under the ridge to Holme End Bridge in the Walshaw Dean valley, then skirts the hills to Crimsworth Dean, where it crosses the valley at a depth of more than 300 feet in cast-iron syphon pipes, shortly after enters a tunnel at Pecket Well (2500 yards in length, called the Castle Carr tunnel), under Wadsworth and Midgley Moors, and joins the Luddenden system at Shore End Wood.

The Walshaw Dean reservoirs are not yet commenced. It is proposed to make three. They will have about the same drainage and nearly the same capacity as the Widdop and Greave system. The conduits from these reservoirs will join the Widdop system at Holme End Bridge. The water from all five valleys will thus be brought to Ramsden Wood for further distribution.

It will be seen from the foregoing that the whole line of conduit resembles a tree, the main trunk being from Halifax to Ramsden Wood—the first branch from Ramsden Wood to Ogden, the next branch Ramsden Wood to Warley Moor, or the Luddenden scheme, the Widdop scheme being an offshoot at Shore End Wood of the Luddenden scheme, these being all complete; and the intended extensions to Walshaw Dean will be an auxiliary to the Widdop scheme, so that the works in the several valleys and their conduits therefrom are one complete system, no one valley or source of supply having a direct line to Halifax, but all dependent for conveyance upon a length of conduit belonging to its adjoining valley. The supply is by gravitation, and the collecting ground or drainage area of the reservoirs is chiefly moorland or high mountain pasture, and of the millstone grit formation—the best known natural filter. The water is delivered in the town pure, and at a high pressure with a constant supply. The higher portion of the town is supplied from a service reservoir at Royles Head, which is supplied from the pumping station at Albert reservoir. The lift is 300 feet.

The water supply is not confined to the borough simply. but embraces a number of out-townships, the population supplied being nearly 250,000.

Thursday, June 27th.

After the adjournment the Members visited the new Technical Schools at Halifax, in course of erection. The party was taken over the buildings by Mr. C. H. Fox, who gave the fullest possible explanation to the Members. The site of the new schools covers 5000 *square yards, and the estimated cost is* 16,000*l. The main building is three stories high, and is divided into four sections for the instruction of students in engineering, chemistry, dying and weaving. The building is the design of Messrs. Jackson and Fox, architects, of Halifax.*

Friday, June 28th.

Immediately after the adjournment from the Town Hall a visit was paid to the works of Messrs. Oates and Green, Limited, at Horley Green and Ellen Royde, under the guidance of Councillor Tyson and Alderman Tattersall. The party were shown specimens of clay from the various mines at Field, Beacon, Bradshaw, *Mytholm, and Ellen Royde, all of which possess different properties specially suitable for different classes of goods. Specimens of the various manufactured goods were inspected, including yard and street gullies. The manufacture of pipes of* 30 *inches diameter was also seen, and the method of making Stanford's joints was also watched with great interest. The Members were entertained to luncheon by Messrs. Oates and Green.*

The Members then proceeded in brakes across the moors to the Corporation Waterworks at Castle Carr, under the guidance of Mr. J. A. Paskin, the waterworks engineer for the Borough of Halifax, who read his paper on the works, and fully explained the various details. On the return to Halifax the new Infirmary buildings were inspected, and visits were paid to the exhibition of sanitary appliances by Messrs. H. Wadsworth and Sons and to the Corporation Gas and Electricity Works.

Saturday, June 29th.

The day's proceedings were opened with a visit to the new Market buildings, which have been erected at a cost of 60,000*l. The Markets are most complete, and are among the architectural features of the town. Thence the Members drove to Messrs. Brooke and Son's stone quarries at Hipperholme, where the party was afforded an opportunity of seeing the quarries in full operation and the quarrying and dressing of the stone. Every facility was given to the Members to thoroughly examine both the method of polishing and working the "Silex" stone. A visit was also paid to the extensive fireclay works of Messrs. Brooke and Son, where luncheon was served. The visit was of considerable interest, and the Members were afforded the fullest opportunity of inspecting the manufactures of the firm.*

APPENDIX.

PAGE
List of Books of Statistics at Offices of the Association 304
Examinations 308
Board of Examiners 318
Certificated Candidates 319

Memoirs of Deceased Members 323

RETURNS, OR BOOKS OF STATISTICS, on the following subjects lie at the Offices of the Association, 11 Victoria Street, Westminster, S.W., and are open to the inspection of Members.

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1. Particulars of Sewage Purification and Disposal. Returns from 41 towns. Compiled by H. Richardson, A. M. Inst. C.E., Town Surveyor, Oldbury. 1890.

2. Statistics relating to Water Supply for Domestic, Trade, Sanitary, Street-watering, and Public Purposes. Information from 111 towns. Compiled by J. T. Eayrs, A. M. Inst. C.E., Borough Surveyor, West Bromwich. 1890.

3. Comparison of Cost and Life of Granite and Gritstone Pavement. Information received from 33 towns. Compiled by C. F. Wike, M. Inst. C.E., Borough Surveyor, Sheffield. 1890.

4. The Collection of House Refuse. Returns from 89 towns. Compiled by J. Price, A. M. Inst. C.E., Surveyor to the Local Board, Toxteth Park. 1891.

5. The Disposal of House Refuse, &c. Returns from 39 towns. Compiled by J. Price, A. M. Inst. C.E., Surveyor to the Local Board, Toxteth Park. 1891.

6. Particulars respecting Tar Macadam. Returns from 72 towns. Compiled by Joseph Hall, A. M. Inst. C.E., Borough Surveyor, Cheltenham. 1891.

7. Information on the Working of Shone's Hydro-Pneumatic System. Returns from 20 towns. Compiled by E. Buckham, M. Inst. C.E., Borough Surveyor, Ipswich. 1891.

8. Tabulated Statement as to Road Watering. Returns from 65 towns. Compiled by W. Dawson, A. M. Inst. C.E., Local Board, Leyton. 1891.

9. Information with reference to Street Tramways. Returns from 48 towns. Compiled by J. E. Swindlehurst, A. M. Inst. C.E., Borough Surveyor, Burton-upon-Trent. 1891.

10. Information with reference to Electric Lighting. Returns from 88 towns and 10 London Vestries. Compiled by J. W. Cockrill, A. M. Inst. C.E., Borough Surveyor, Great Yarmouth. 1891.

11. Particulars of Gas Undertakings in the hands of Local Authorities. Returns from 38 districts. Compiled by Percival Ross, A. M. Inst. C.E., Engineer to the Local Board, North Bierley. 1891.

12. Information obtained relative to the Construction of Works of Private Street Improvements. Returns from 49 towns. Compiled by W. J. Newton, A. M. Inst. C.E., Borough Surveyor, Accrington. 1892.

13. Information respecting Sewage Disposal. Returns from 53 towns. Compiled by J. H. Cox, M. Inst. C.E., Borough Surveyor, Bradford. 1892.

14. The Meteorology of Nottingham. Also Chart showing the relation of the Number of Deaths from various causes to Meteorological Conditions for 1891–1895. Compiled by A. Brown, M. Inst. C.E., Borough Surveyor, Nottingham, and Philip Boobbyer, M.B.

15. Particulars obtained from 54 towns respecting Public Street Lighting. May 1892. Surveyor, Local Board, Dalton-in-Furness.

16. Use of Steam Road-Rollers. Particulars obtained from 42 towns and districts. Compiled by A. W. Parry, A. M. Inst. C.E., Reading.

17. Ventilation of Sewers. Statement of replies from 81 towns. Compiled by J. T. Earnshaw, A. M. Inst. C.E., Ashton-under-Lyne.

18. Electric Lighting. Information and Statistics from 58 towns. Compiled by W. A. Davies, A. M. Inst. C.E., Aston Manor.

19. House Drainage. Information from 31 towns. 1894. Compiled by J. Atkinson, A. M. Inst. C.E., Stockport.

20. Main Roads. Maintenance of, in Non-County Boroughs. Particulars from 83 towns. Compiled by W. H. Smith, A.M.I.C.E., Carlisle.

21. Slaughter Houses. Information obtained from 22 towns. Compiled by J. W. Cockrill, A. M. Inst. C.E., Great Yarmouth.

22. Electric Lighting. Replies from 38 towns. Compiled by J. W. Brown, A. M. Inst. C.E., West Hartlepool.

Reports, Specifications and other Particulars of the Blackburn Corporation Municipal Works. J. B. McCallum, Borough Engineer.

Fever Hospital. Description of the Blackburn. By J. B. McCallum.

Havre, Question d'Assainissement.

Bye-laws of the Audenshaw Local Board.

Some Recent Advances in Water Analysis for the Detection of Sewage Contamination. By Geo. W. Rafter.

Measures for Restricting the Use and Waste of Water in force in Rochester, N.Y. By Geo. W. Rafter.

The Hydraulics of the Hemlock Lake Conduit of the Rochester Water Works. By Geo. W. Rafter.

Genesee River Storage Surveys. By Geo. W. Rafter.

Sewerage of Geneva. By Geo. W. Rafter.

Filtration of Sewage. By Geo. W. Rafter.

Reports.

Annual Reports, City Surveyor, Sydney. 1889–94.

Means of Regulating Vehicular Traffic. City Surveyor, Sydney. 1891.

Specification, Wood Paving and Cube Sett Paving. City Surveyor, Sydney.

Report upon the Disposal of Refuse, &c., in Cities of Melbourne and Adelaide. City Surveyor, Sydney. 1891.

Yearly Report. City Surveyor, Montreal. 1890.

Report on Cable Tramways. Borough Surveyor, Bradford. 1890.

Annual Reports. Surveyor Local Board, Willesden. 1890–92.

Annual Reports. Surveyor to the Vestry of Fulham. 1890–91.

Annual Reports. Borough Surveyor, Stockport, to the Highways and Sewers Committee. 1890–92.

Report on the Collection and Disposal of House Refuse. Surveyor to Local Board, Wimbledon. 1891.

Annual Report. City Surveyor, Montreal. 1891.

Annual Report of the Metropolitan Board of Water Supply and Sewerage. Sydney. 1891.

Annual Report of Borough Surveyor of Stockport. 1891–92.

Papers on Sewer Ventilation, with Report of Mr. Gilbert Redgrave. 1891.

Report on Lighting the City of Liverpool by Electricity. City Engineer, Liverpool. 1892.

Description of the Sewage Disposal Works of the County Borough of Burnley. By F. S. Button.

Report on Drainage. Frognall and Oak Hill Park, Hampstead 1892.

Annual Reports of Executive Board of Rochester for the years 1888, 1889, and 1890.

VOLUNTARY EXAMINATIONS.

SYLLABUS.

THE INCORPORATED ASSOCIATION OF MUNICIPAL AND COUNTY ENGINEERS undertake the holding of Voluntary Pass Examinations for Candidates for Surveyorships under Municipal Corporations and the Local Government Acts.

There are two Examinations in each year, one in April, in London, and one in October, in some provincial town to be fixed on by the Council and advertised six months beforehand.

The Examinations are by written papers and *vivâ voce*, upon the four following subjects :—

1st. Engineering as applied to Municipal Work.
2nd. Building Construction and Materials.
3rd. Sanitary Science as applied to Towns and Buildings.
4th. Public Health Acts, and Rivers Pollution Acts.

Candidates are allowed two hours to answer the questions under each of the four heads, and are not necessarily required to answer all the questions set in each paper, though not less than four must be taken: marks are given for all questions properly answered. The *vivâ voce* examination is held after the written papers have all been sent in, and is directed to the further elucidation of the answers to the papers on each subject, and to such practical points as fairly arise therefrom.

The Examinations extend over one or two days, as circumstances may require, and in the latter case the arrangements are, as far as possible, as follows:—

First day ..	10	to	12 ..	Engineering.
" ..	2	„	4 ..	Building Construction.
" ..	5	„	7 ..	Sanitary Science.
Second day ..	9.30	„	11.30 ..	Public Health Law.
" ..	12	„	4 ..	*Vivâ voce* Examination.

The total number of marks required to constitute a pass is 50 per cent. in each of the subjects.

Each candidate has to fill a Form of Application, to be obtained from the Secretary.

Candidates must have attained their twenty-second birthday.

The fee for each Examination is 3*l.* 3*s.*, one guinea to be paid on application, and the balance on the day of examination. Should the candidate fail, he is entitled to present himself again at the next or any subsequent Examination, on payment of one-half of the above fee, one guinea to be paid on application and half a guinea on the day of Examination.

No further charge is made to the candidate than the fees above mentioned.

Candidates who do not present themselves for the Examination forfeit the entrance fee.

Successful candidates will receive a Certificate in the form of a "Testamur," signed by the Examiners for the time being, and countersigned by the President and Secretary of the Association in Council.

Further details and particulars may be obtained on application to Mr. Thomas Cole, Secretary to the Association, 11 Victoria Street, S.W.

SUBJECTS OF EXAMINATION.

I.—Engineering as applied to Municipal Work:

A. Land Surveying and Levelling.
B. Hydraulics.
C. Sewerage and Sewage Disposal Works.
D. Water Supply.
E. Road Making.

II.—Building Construction: Strength of Materials:

A. Materials.
B. The Construction of Public and Private Buildings.
C. Building Bye-laws.
D. Public Baths and Hospitals.

III.—Sanitary Science as applied to Towns and Buildings:

A. Ventilation of Buildings.
B. Scavenging and Disposal of Refuse.
C. House Drainage.
D. Disinfection.

IV.—Public Health Acts. Rivers Pollution Acts.

Note.—The Examiners do not recommend any particular text-books, as it is desired to make the Examinations rather a test of the candidate's practical knowledge of the subjects generally, than to find his aquaintance with any particular book or books.

EXAMPLES OF QUESTIONS.

The following are the Examination Papers set to the candidates at the Eighteenth Examination, held at the Council House, Birmingham, on the 5th and 6th October 1894.

SUBJECT :—ENGINEERING AS APPLIED TO MUNICIPAL WORK.

Examiner : Edward Pritchard, M. Inst. C.E.

LAND SURVEYING AND LEVELLING.

1. Enumerate some of the principal instruments used in land surveying, and describe their uses.
2. Give the contents in statute acres, roods and perches of an irregular polygon. (Diagram given.)
3. Give a sketch page of a Level Book and show imaginary readings, with five changes of the instrument. Reduce the levels and prove their accuracy.

HYDRAULICS.

4. What is the definition of hydraulics?
5. Describe the action of a syphon.

DRAINAGE AND SEWERAGE.

6 Give dimensions, depths and inclinations of pipes for a system of house drains (with a connection to a 12-inch sewer), for one pair of semi-detached villas, with ten inhabitants to each. Give sketch to illustrate same.

7. Describe the precautions necessary to prevent sewer gas entering dwelling-houses having inside w.c.'s. Give sketch showing pipes and other works of drainage for the same.
8. Give sketch of a combined manhole and storm overflow chamber.

WATER SUPPLY.

9. Write a short specification of the fittings necessary in a house supplied with water from a service reservoir 150 feet above the ground level of the house. Specify tests to which pipes, taps, &c. should be subjected.
10. State the disadvantages of an *intermittent* supply.

ROAD MAKING.

11. Give sketch transverse section of a carriageway and footpaths, 45 feet between buildings, showing a double line of tramway (3 feet 6 inch gauge) in position.*

12. Describe the construction of a roadway in tarred macadam, the ingredients and method of mixing, and state any advantages or disadvantages of this system of road making.

SUBJECT:—BUILDING CONSTRUCTION, &c.

Examiner: W. G. Laws, M. Inst. C.E.

1. Describe shortly the various bonds used in brickwork, with sketches.

2. Describe shortly—
   (*a*) Common rubble masonry.
   (*b*) Snecked rubble.
   (*c*) Block in course.
   (*d*) Ashlar.

3. Describe the usual construction of the floors of an ordinary dwelling-house, giving a sketch.

4. What tensile strain should good Portland cement bear per square inch, the briquette having been seven days in water?

5. Describe the process of making mortar from stone lime, and give best proportions of sand and lime.

6. What are the woods chiefly used in building, and for what purposes? Give the commercial sizes of Norway red pine.

7. What is a "Mansarde" roof, and how are the timbers arranged? Give sketch.

8. Give a sketch showing how a roof is slated, showing the purlins, common rafters and slate laths.

9. Where would you put in inverted relieving arches in a large warehouse built on an ordinary clay foundation?

10. In converting a dwelling-house into "shop below and residence above," how would you shore up while putting in the pan-beam for the shop window?

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* This sketch must show the detailed construction of flagged footpath, paved carriageway (5 inches deep), inclinations of footpaths, contour of carriageway, and full dimensions of constructive materials.

SUBJECT:—SANITARY SCIENCE.

Examiner: A. M. Fowler, M. Inst. C.E.

AIR.

1. What are the principal component parts of the atmosphere, i.e. what does the air consist of?
   - (*a*) What are the deleterious gaseous matters of the atmosphere?
   - (*b*) Under what influence are such matters neutralised?
   - (*c*) State the most beneficial to health.
2. In what way does nature assist ventilation otherwise than by atmospheric currents?

WATER.

3. State the maximum amount of solids in grains per gallon drinking water should not exceed.
   - (*a*) State the maximum limit in like manner of chlorine.
   - (*b*) State the maximum degrees of hardness water should not exceed for domestic use.
4. What are the best known means for softening hard water?

SUBJECT:—PUBLIC HEALTH ACTS AND RIVERS POLLUTION ACTS.

Examiner: Joseph Lobley, M. Inst. C.E.

1. Give the definitions under the Public Health Act, 1875, of "sewer," "drain," "street," "owner."
2. Describe the principal provisions of the Private Streets Works Act, 1892, and state what Urban Authorities are affected.
3. Where defective drainage exists in the yard of a dwelling, describe the measures to be taken to remedy the nuisance under the following circumstances, and name the clauses of the Public Health Act, 1875, authorising the course to be taken.
   - (*a*) When the authority desire to do the work after the owner has neglected it.
   - (*b*) When the authority do not desire to do the work themselves, but prefer the owner should take his own measures.
   - (*c*) Where a row of houses require back drainage, and where a back sewer could readily be constructed. State the clause and the conditions necessary to enable this course to be taken.
   - (*d*) Would such sewer become repairable by the authority? Give the name of any Act affecting this question other than the Public Health Act, 1875.

4. Where a defective and insanitary privy exists in the yard of a dwelling, describe in like manner to question No. 3 the different modes of dealing with the nuisance.

5. What is the distance that an owner can be required to connect his drains to the public sewer, and what steps must the authority take where there is no sewer within that distance, and how is the cost of the work to be defrayed?

6. Describe the measures to be taken when the authority desire to widen an existing street, some of the owners not consenting to sell the necessary land—

   (*a*) When the authority wish to complete the improvement within a comparatively short time.
   (*b*) When the authority are willing to deal with each building when the owner desires to take down and rebuild.

7. State shortly the necessary proceedings under the Rivers Pollution Act—where polluted liquid is discharged into a watercourse.

8. State shortly some of the principal powers of a Local Authority under the Housing of the Working Classes Act, 1890, describing the course to be taken in dealing with a group of houses unfit for habitation.

9. State the provisions under the Factory and Workshop Act, 1891, as to cleanliness, water closets, fencing machinery, provision against fire; and name the Act dealing with sanitary conveniences for manufactories.

EXAMPLES OF QUESTIONS.

The following are the Examination Papers set to the candidates at the Nineteenth Examination, held at the Institution of Civil Engineers, Westminster, on the 5th and 6th April 1895.

SUBJECT :—ENGINEERING AS APPLIED TO MUNICIPAL WORK.

Examiner : A. M. Fowler, M. Inst. C.E.

WATERWORKS.

1. State the best form of construction for filter beds, giving sketch of cross section.
   - (*a*) What quantity of water can be passed through a filter bed per square yard in 24 hours, i. e. to secure satisfactory results?
   - (*b*) State the difference between a gradient having a regular incline and a hydraulic gradient on an undulating line, as in the case of an iron conduit, where the pipes are under pressure.
   - (*c*) Suppose a reservoir 200 feet above the supply pipes in a town, what would be the pressure in lbs. per square inch on them?
   - (*d*) Give formula for calculating the pressure on the mains.
   - (*e*) State the maximum degrees of hardness of water, which should be sought to be obtained for domestic use.

SEWERS.

1. Suppose a sewer, equal to 5 feet diameter, with an inclination of 1 in 2000, what would be the best form in cross section to adopt to secure the best velocity in the flow of sewage through the same? Give sketch.
   - (*a*) What is the minimum velocity in the flow of sewage, which should be sought to be obtained in a system of sewers?
   - (*b*) What is meant by the hydraulic mean depth?
   - (*c*) When out "in the field" what means would you adopt to ascertain as to whether or not your spirit level was in adjustment?

STEEL BRIDGES (of 100 feet span and say 40 feet wide).

1. State the most economical proportion for depths of girders with regard to the span.
   - (*a*) State formula for obtaining cross sectional area at top and bottom boom respectively.

- (*b*) State the distance rivets should be placed apart in ordinary work.
- (*c*) The thickness of floor plates generally adopted.
- (*d*) State the tensile strain per square inch steel should withstand.
- (*e*) State the elongation per cent. the same should withstand without fracture.

TRAMWAYS IN TOWNS.

1. State the best form of steel rail, in cross section, giving sketch, for adoption for horse tramways.
    - (*a*) State the weight about per lineal yard of steel rail you would recommend.
    - (*b*) State the most durable mode of construction, giving sketch of cross section.
    - (*c*) The most appropriate pavement.
    - (*d*) And in what material the pavement should be set; state some of the methods adopted.

SUBJECT:—BUILDING CONSTRUCTION, &c.

Examiner: W. G. Laws, M. Inst. C.E.

1. Give the composition of good mortar. What are the usual faults in "bad" mortar, and how detected?
2. Compare lime mortar and cement mortar, and say where each is most applicable.
3. Show a sketch of a window-casing and the adjoining brickwork. What is the "reveal"?
4. Give a sketch of an ordinary wood staircase, showing how the treads and risers are fitted into the frames in good work. Give a good rule for the proportions of tread and riser.
5. In joining timbers longitudinally, what are the three most usual modes of jointing? Give sketches, and compare them as to strength.
6. Show sketch of a window opening with "head," "sill," and "jambs," of stone, and explain why the stones are laid in that way. Why do you set the sill hollow on the brickwork?
7. Specify, briefly, for the plaster work of dwelling-room in an ordinary house of 50*l.* rental.
8. How would you proceed to shore up a dangerous building (in a main street) the front of which shows signs of falling?
9. What are the chief requirements in arranging the exits from public buildings, as to doors, stairs, &c.?
10. Describe the plumbing work required about a "hip and valley" roof. Specify the weight of lead for the various parts, with any special precautions required.

SUBJECT :—SANITARY SCIENCE.

Examiner: Charles Jones, M. Inst. C.E.

ISOLATION HOSPITAL.

(*a*) Give a sketch plan of isolation hospital for a population of 30,000.

(*b*) Describe shortly its more important requirements in construction, ventilation, and warming.

(*c*) General administration, removal of patients, ambulance, &c.

(*d*) The best mode of dealing with slop and excreta from hospital and laundry.

WATER SUPPLY (Domestic).

Describe the best known method of dealing with the water supply of dwelling houses—its collection in cisterns or otherwise, and the mode you would adopt in construction to avoid the inconvenience of severe frost.

FAILURE OF WATER SUPPLY.

Taking the late Water Famine as a basis.

What plan would you adopt in any district under your charge, where through severe frost or other causes the ordinary supply for domestic and sanitary purposes has failed?

EPIDEMIC.

In case of an outbreak of a virulent epidemic in your district, what means would you employ for dealing with the difficulty?

(*a*) Amongst the poorer classes—courts and alleys.

(*b*) Amongst the better class—bye roads, villa residences.

(*c*) Roads and sewers.

SUBJECT :—PUBLIC HEALTH ACTS AND RIVERS POLLUTION ACTS.

Examiner: John T. Eayrs, M. Inst C.E., F.S.I., &c.

1. What effect has Sec. 19 Public Health Act Amendment Act, 1890, on the meaning of "drain" as defined in Sec. 4 Public Heath Act, 1875?
2. A Local Authority lays down a new system of sewers, and requires all existing drains to be connected therewith. What are the powers and duties of the Local Authority to secure the work being done?
3. State briefly the objects of the Public Health Act (Support of Sewers) Amendment Act, 1883, and the provisions contained therein?

4. What is the weak point in the following Section of the Public Health Act, 1875?

> "It shall not be lawful in any Urban District without the written consent of the Urban Authority to bring forward any house or building forming part of any street or any part thereof beyond the front wall of the house or building on either side thereof nor to build any addition thereto beyond the front of the house or building on either side of the same."

How has it been amended?

5. In case of a dispute as to the amount of compensation to be made under the Public Health Act, what provision is made as to the settlement thereof and in case of arbitration, give the mode of reference and regulations governing such arbitrations?

6. What powers have a Local Authority as to—
   - (*a*) The erection and maintenance of statues and monuments in streets.
   - (*b*) Planting of trees in highways.
   - (*c*) Providing, maintaining or contributing towards public clocks.

7. Under what Acts are the following matters dealt with, and give the general provisions relating to—
   - (*a*) Spouting houses or buildings.
   - (*b*) Hoardings.
   - (*c*) Dangerous places.
   - (*d*) Sanitary conveniences for manufactories.
   - (*e*) Ingress to, and egress from places of public resort.
   - (*f*) Safety of platforms used on public occasions.

8. Give the general provisions in the Towns' Improvement Clauses Act and Towns' Police Clauses Act, 1847, relating to projecting signs, blinds and awnings. Have Local Authorities power to prevent sign-boards being erected which project over the public footway, if so, under what Act, and under what conditions?

9. State briefly the provisions of the Rivers Pollution Prevention Act, 1876. Has any subsequent legislation taken place with regard to it, and if so, of what nature?

BOARD OF EXAMINERS.

The President of the Association (*ex-officio*).

Lewis Angell, M. Inst. C.E., F.R.I.B.A., Fellow of King's College, London, Borough Engineer, West Ham (Past President).

H. P. Boulnois, M. Inst. C.E., City Engineer, Liverpool (Past President).

J. Cartwright, M. Inst. C.E., Borough Surveyor, Bury, Lancashire (Past President).

W. Santo Crimp, M. Inst. C.E., F.G.S., M.S.I., late District Engineer, London County Council.

J. T. Eayrs, M. Inst. C.E., F.S.I., Borough Surveyor, West Bromwich (Past President).

E. B. Ellice-Clark, M. Inst. C.E., late County Surveyor, West Sussex (Past President).

A. M. Fowler, M. Inst. C.E., Manchester, Water Engineer, Northallerton (Past President).

C. Jones, M. Inst. C.E., Surveyor to the Urban District Council, Ealing, W. (Past President).

W. G. Laws, M. Inst. C.E., City Engineer, Newcastle-on-Tyne (Past President).

James Lemon, M. Inst. C.E., F.R.I.B.A., Consulting Engineer, Southampton (Past President).

Jos. Lobley, M. Inst. C.E., Borough Engineer, Hanley (Past President).

T. De C. Meade, M. Inst. C.E., M. Inst. M.E., City Engineer, Manchester (Past President).

E. Pritchard, M. Inst. C.E., 37 Waterloo Street, Birmingham (Past President).

CANDIDATES WHO HAVE PASSED THE EXAMINATION.

Date of Certificate.	
May 7, 1887	Adcock, C. (Liverpool).
May 2, 1891	Allen, S. (Radcliffe).
Apr. 22, 1893	Anderson, H. E. (Norwood).
Apr. 23, 1892	Anderson, J. R. (Norwood).
May 1, 1886	Angell, J. A. (Leytonstone).
May 19, 1894	Angel, R. J. (Birkenhead).
Oct. 20, 1894	Armstrong, J. G. D. (Manchester).
May 1, 1886	Ashmead, H. (Clifton).
Oct. 19, 1889	Aspinall, M. (Cardiff).
Apr. 20, 1895	Atkinson, W. (Bradford).
May 2, 1891	Ball, B. (Middleton).
Oct. 18, 1890	Ball, C. F. (Croydon).
Oct. 16, 1886	Ball, G. (Scarborough).
Apr. 23, 1892	Ball, J. B. (King's Cross).
May 12, 1888	Barnes, S. W. J. (Ealing).
Oct. 15, 1892	Bassett, G. T. (Birmingham).
May 12, 1888	Bayley, G. H. (Salford).
Oct. 16, 1886	Beard, E. T. (Lincoln).
May 12, 1888	Beynon, J. C. S. (Exeter).
Apr. 22, 1893	Birch, J. E. W. S. (Norwood).
Apr. 13, 1889	Blizard, J. H. (Southampton).
Apr. 13, 1889	Bradley, J. W. (Burnley).
Oct. 21, 1893	Bradshaw, F. E. G. (Brighton).
Oct. 20, 1894	Bradshaw, H. G. (Rochdale).
Apr. 23, 1892	Bradshaw, J. B. (Gateshead).
Oct. 21, 1893	Brander, J. J. (Aberdeen).
Nov. 17, 1888	Brown, R. R. (Bridlington Quay).
May 19, 1894	Brown, R. (Ealing).
Oct. 16, 1886	Brownridge, C. (Leeds).
Apr. 22, 1893	Brumell, W. F. G. (Redhill).
May 12, 1888	Bryans, J. G. (Sunderland).
Nov. 17, 1888	Bryning, W. G. (Liverpool).
Oct. 19, 1889	Bucknall, H. (Stratford-on-Avon).
Oct. 20, 1894	Burton, A. (Manchester).
Apr. 13, 1889	Carter, G. F. (Leeds).
May 3, 1890	Catchpole, J. H. (Hendon).
Apr. 22, 1893	Chasemore, A. E. (Putney).

Date of Certificate.	
May 19, 1894	Clarke, A. H. F. (Kingston-on-Thames).
May 19, 1894	Claypoole, A. H. (York).
May 19, 1894	Clegg, H. (Burnley).
May 19, 1894	Coales, A. F. (Chelsea).
May 1, 1886	Coales, H. G. (King's Lynn).
Apr. 22, 1893	Colson, C. H. (Portsmouth).
May 19, 1894	Connah, E. (Glasgow).
Oct. 22, 1887	Cook, J. (Bury).
May 12, 1888	Cooper, C. H. (Wimbledon).
May 7, 1887	Cooper, F. E. (Liverpool).
May 2, 1891	Cooper, W. (Cheetham).
Apr. 20, 1895	Creswell, W. T. (Aldershot).
Apr. 23, 1892	Cross, F. W. (Walsall).
May 12, 1888	Crow, A. (Stratford, E.).
Oct. 16, 1886	Crowther, J. A. (Leeds).
Oct. 21, 1893	Dawson, J. H. (Liverpool).
May 19, 1894	Daye, J. (Cardiff).
May 7, 1887	Dearden, Hy. (Leeds).
May 2, 1891	Dixon, J. R. (Carlisle).
Apr. 13, 1889	Dixon, W. B. (Wolverhampton).
Oct. 17, 1891	Dolamore, F. P. (Bournemouth).
Oct. 18, 1890	Dyack, W. (Aberdeen).
Oct. 18, 1890	Edge, F. J. (Barrow-in-Furness).
Apr. 20, 1895	Elford, E. J. (Norwich).
May 1, 1886	Fenton, W. C. (Sheffield).
Nov. 17, 1888	Field, W. C. (Eastbourne).
May 12, 1888	Finch, A. R. (Finchley).
Apr. 22, 1893	Finglah, F. J. (Walsall).
Apr. 23, 1893	Fitton, G. (Reading).
Apr. 20, 1895	Forbes, A. H. (Tottenham).
May 7, 1887	Franks, T. W. (West Bromwich).
Oct. 19, 1889	Gaffney, F. S. B. (Athleague).
May 3, 1890	Gibbs, L. (Walsall).
May 12, 1888	Glass, S. N. (Hackney).
May 12, 1888	Gloyne, R. M. (Manchester).
Oct. 21, 1893	Gordon, Junr., J. (Aberdeen).
May 2, 1891	Graves, M. D. (York).
May 1, 1886	Greatorex, A. D. (Toxteth Park).
Oct. 20, 1894	Green, W. S. (Derby).
Oct. 15, 1892	Greenwood, J. P. (Barry).
Oct. 18, 1890	Hall, W. (Ealing, W.).
Nov. 17, 1888	Hawkins, I. T. (Chichester).

Date of Certificate.	
Oct. 15, 1892	Hellawell, O. (Withington).
Apr. 20, 1895	Hendry, J. S. (West Bromwich).
Oct. 20, 1894	Hickes, E. W. (Truro).
Apr. 23, 1892	Hills, H. J. (Clapham).
Apr. 20, 1895	Hodgkinson, G. (Manchester).
May 12, 1888	Houghton, J. (King's Heath).
Oct. 20, 1894	Hughes, A. H. (Wrexham).
May 2, 1891	Hurd, H. (Bath).
Oct. 17, 1891	Ingham, W. (St. Helen's).
Oct. 16, 1886	Jameson, M. W. (Leeds).
Apr. 20, 1895	Jenkins, A. J. (Rochdale).
Apr. 20, 1895	Julian, J. (Cambridge).
Apr. 22, 1893	Killick, W. H. (Southampton).
Oct. 15, 1892	Lacey, G. W. (Kettering).
Apr. 23, 1892	Lloyd, C. (Chatham).
Apr. 20, 1895	Lobley, F. J. (Hanley).
May 12, 1888	Lynam, G. T. (Barnsley).
Oct. 16, 1886	Mallinson, T. (Selby).
Oct. 18, 1890	Manley, J. (Liskeard).
Oct. 21, 1893	Martin, E. B. (Leeds).
Oct. 22, 1887	Mellor, T. E. W. (Stockton).
Oct. 22, 1887	Metcalf, J. W. (York).
May 3, 1890	Miller, J. E. (Durham).
Nov. 17, 1888	Millington, J. S. (Wavertree)
May 12, 1888	Milnes, G. P. (Wakefield).
Oct. 17, 1891	Naylor, W. (Wolverhampton).
Apr. 13, 1889	Nettleton, H. (Leeds).
Apr. 20, 1895	Newham, J. T. (Birmingham).
Oct. 20, 1894	Newton, E. B. (Carlisle).
May 7, 1887	Nichols, A. E. (Leeds).
May 7, 1887	Nickols, F. J. (Leeds).
Oct. 19, 1889	Noakes, H. S. (Tunbridge Wells).
Oct. 20, 1894	Openshaw, J. (Sheffield).
May 1, 1886	Osborne, F. (Dover).
Oct. 20, 1894	Palliser, W. A. (Mexboro).
Oct. 22, 1887	Parker, W. (Hereford).
Oct. 15, 1892	Parr, N. (Walsall).
Oct. 20, 1894	Perkins, J. (Balsall Heath).
Oct. 15, 1892	Perkins, T. L. (Bristol).
Oct. 16, 1886	Pickering, J. S. (West Bromwich).
Oct. 21, 1893	Pickering, S. A. (Burnley).
Oct. 21, 1893	Pickles, T. H. (Burnley).

Date of Certificate.	
Apr. 20, 1895	Poulden, G. E. (Southsea).
Oct. 19, 1889	Preston, T. (Bradford).
May 19, 1894	Price, A. J. (Brighton).
May 12, 1888	Pritchard, T. (Richmond).
Apr. 22, 1893	Putman, W. E. (Leeds).
May 7, 1887	Rich, E. W. (Hounslow).
Oct. 17, 1891	Roberts, F. (Birkenhead).
May 2, 1891	Saise, A. J. (Stapleton).
May 1, 1886	Saunders, E. E. (Walthamstow).
May 7, 1887	Saunders, J. (Newark).
Oct. 21, 1893	Savage, E. B. (Sheffield).
Oct. 22, 1887	Saville, R. W. S. (Accrington).
May 19, 1894	Settle, J. A. (Darwen).
Apr. 23, 1892	Shackleton, C. W. (Coseley).
Oct. 16, 1886	Silcock, E. J. (Leeds).
Oct. 20, 1894	Slater, W. (Nottingham).
May 19, 1894	Smith, W. (Swanage).
Oct. 21, 1893	Steele, W. J. (West Hartlepool).
Apr. 13, 1889	Stringfellow, W. (Southampton).
Oct. 18, 1890	Sumner, F. (Kilburn).
Oct. 16, 1886	Sykes, E. (Reddish).
Apr. 13, 1889	Taylor, W. J. (Southampton).
Oct. 20, 1894	Thackeray, F. (Darwen).
Oct. 16, 1886	Thomas, R. J. (Carnarvon).
Oct. 19, 1889	Thomas, T. (Neath).
Apr. 13, 1889	Tomes, G. B. (Eastbourne).
May 19, 1894	Trew, G. H. M. (Lavender Hill, S.W.)
Oct. 16, 1886	Turner, V. H. (Leeds).
Apr. 20 1895	Uren, F. C. (Penzance).
Apr. 23, 1892	Veit, L. J. (Ipswich).
May 7, 1887	Verschoyle, B. (Liverpool).
Apr. 22, 1893	Videan, Hy. (Stafford, E.).
Oct. 22, 1887	Ward, F. D. (Manchester).
Apr. 20, 1895	Williams, D. S. (Mountain Ash).
May 12, 1888	Wilson, C. L. N. (Bacup).
Nov. 17, 1888	Wilson, J. B. (Cockermouth).
May 1, 1886	Witts, J. W. (Skelton).
May 3, 1890	Wood, J. W. (Rochdale).
Oct. 20, 1894	Worrall, F. (Leicester).
Oct. 15, 1892	Wright, J. A. (Bristol).
May 2, 1891	Yarwood, Hy. (Rochdale).
Apr. 23, 1892	Yates, F. S. (York).
Oct. 16, 1886	Young, W. (Pendleton).

Memoirs of Deceased Members.

The Council, having been requested to append some short notice of the decease of Members of this Association, will feel obliged by early notice being forwarded to the Secretary, with such particulars as it may be desirable to insert in these 'Proceedings.'

WILLIAM BRENTNALL, born on the 30th of March, 1829, was a native of Ilkeston in Derbyshire, where his father was in business as a builder and contractor. In 1855 he became an assistant to the late Mr. Edward Price, who had entered into a contract with the Brazilian Government for the construction of the Dom Pedro Segundo Railway from Rio de Janeiro to the foot of the Serra S. Anna, a distance of forty miles. Mr. Brentnall, whose position was that of Superintendent of Bridge Construction, suffered, whilst on those works, from ague and yellow fever, which proved fatal to many of the English assistants. He returned home in 1858, and was then engaged for Mr. (now Sir Robert) Rawlinson in superintending the construction of part of the West Ham main sewerage. From 1864 to 1870 he was employed as resident engineer, under the late Mr. John Lawson, on the sewerage of Keswick, Cockermouth and Workington, and on the waterworks of Maryport.

In 1870 Mr. Brentnall was appointed surveyor and waterworks engineer to the Borough of Tunbridge Wells. During the twenty-four years he occupied that position he carried out considerable extensions to and improvements in the collecting, impounding and distributing arrangements of the waterworks. These comprised the construction of a storage-reservoir — containing 45,000,000 gallons—formed by two earthern embankments across a valley in bad ground and made watertight by an internal lining of concrete and asphalt; the erection of a considerable addition to the pumping-station buildings and a duplication of the pumping plant and rising-main; and many alterations of the internal distributing pipes, with an extension of a subsidiary gravitation supply, which resulted in considerable saving in pumping charges. By careful arrangements for the detection of waste, and by conciliatory treatment of householders, the consumption of water was reduced to 18 gallons per head, including street-watering—as low a rate as can reasonably be expected in a fashionable residential town.

Mr. Brentnall also erected a sewage-pumping station for a suburban district unprovided by the two gravitation outfalls to the north and south farms. This included a small covered reservoir; a substantial brick building, containing a pair of gas engines; and a rising-main delivering the sewage into the southern outfall system. He carried out an extension of the Southern Farm, and laid many miles of new sewers. One of his chief works was the design and construction of the Grosvenor Bridge, which carries a public road by three plate-girder spans over the South Eastern Railway near the goods station. He laid out the Borough Cemetery and the Corporation Recreation Grounds; carried out numerous street and town improvements; had charge of the maintenance of between forty and fifty miles of road; and recently designed and built the handsome Council Chamber and Mayor's Parlour in the Town Hall, and also rebuilt the Municipal Offices.

Mr. Brentnall died on the 20th of June, 1894, after several weeks' illness. An operation, performed at Guy's Hospital, disclosed the fact that he was suffering from a cancerous tumour, to touch which would have caused immediate death. The wound healed, but nothing could be done to save his life, and he died six days after the operation. His early training in the practical details of the building trade admirably fitted him to direct and supervise works of construction. He was never content unless he obtained the best work of its kind in every department; and he has left a mark upon the town of Tunbridge Wells which will be an enduring memorial of many years' faithful service.—*Excerpt Minutes of Proceedings of the Institution of Civil Engineers*, vol. cxviii. p. 442.

Mr. Brentnall was a Member of the Institution of Civil Engineers, and was elected a Member of this Association on the 13th of July, 1893.

Peter Burtchaell was the second son of David Burtchaell, of Brandondale, co. Kilkenny, and Jane, daughter of Gilmore Dames, of Dublin. He was born in Kilkenny on the 31st of October, 1820, educated at the Feinaiglian Institution, Dublin, and served his apprenticeship to Mr. Johnson, the county surveyor of Wexford. In 1852 he was appointed county surveyor of Carlow, and was transferred to the county and city of Kilkenny in December 1860. He tendered his resignation of these offices at the Spring Assizes in 1894. While county surveyor of Kilkenny the principal work he was engaged in carrying out was the new free bridge over the Barrow at New Ross, connecting the counties of Kilkenny and Wexford. He had been appointed one of the Commissioners to take steps for erecting a similar free bridge between these counties at Ferry Mountganet, and was about to proceed to Dublin in connection with signing the report on this work, when he was seized with an attack of heart disease, which terminated fatally after a few hours' illness on the 21st of June, 1894, at his residence, Larkfield, Kilkenny. Previous to his being appointed county surveyor he was engaged on many railway surveys, and on drainage and land improvement works under the Board of Public Works (Ireland). He also carried out, as contractor, the construction of several important lines of new county roads, bridges, &c., in the counties of Kilkenny, Carlow and Waterford. He was a Member of the Institution of Civil Engineers, London, and a Member of the Institution of Civil Engineers of Ireland, but resigned his membership some years before his death. Mr. Burtchaell was elected a Member of this Association in October 1891. Mr. Burtchaell was of a kind and genial disposition, and was held in high esteem by his brother county surveyors in Ireland; and the loss of one whose advice and counsel were always sought for at the Annual Meetings of county surveyors in Dublin will be long felt.

Mr. Albert Woodward Parry, A.M.I.C.E., F.S.I., the late borough surveyor of Reading, died at his residence, Airedale, Carnarvon Road, Reading, on the 13th of July, 1894. Deceased had been ailing for some time, but up to within the last two months of his life, nothing of a serious nature was anticipated. About this time, however, his health broke down, and he had to relinquish his duties at Norwich, where he had accepted a temporary engagement, acting as engineer during the illness of the surveyor of that city.

Mr. Parry returned to Reading, and, gradually getting worse, he succumbed to cancer from which he had been suffering.

Deceased, who was the son of Mr. Richard Parry, builder, &c., of Salford, was born on the 19th of January, 1834, and was thus in his sixty-first year, On leaving school, he served his articles with Mr. Thos. T. Smith, architect and surveyor, of Manchester, and subsequently returned to Salford, where he held a post in the surveyor's office. He was for eight years deputy engineer for the Corporation of Bradford. He was appointed borough surveyor by the Corporation of Reading in October 1871, in succession to Mr. C. Woodman, and held that post until 1891, when it was taken over by Mr. A. E. Collins. During his twenty years' connection with the Corporation, Mr. Parry was engaged in a series of important works associated with the improvement and enlargement of the borough, one of his first duties being the completion of the sewerage works, which at the time of his appointment were in the hands of Mr. James Mansergh, C.E., and were being proceeded with under the direction of the resident engineer, Mr. Donaldson. Amongst other important public works carried out while he was surveyor were the widening and paving of several streets, the erection of the Manor Farm Buildings, the extension of the borough, the enlargement of the waterworks, &c. It is worthy of note that when Mr. Parry came to Reading the population of the borough was only about 32,000, whilst on his retirement it had almost doubled, a fact which speaks well for the important public works carried out in the town during his term of office. Since his retirement from the Corporation as surveyor, Mr. Parry acted as consulting engineer to the Corporation, and also carried on a private practice at Reading and at Westminster. In 1873 he was elected a Member of this Association, and for several years he was a vice-president and member of the council. The deceased gentleman was also one of the oldest members of the Berks Archæological Society and a prominent Freemason.

James Braddon McCallum was born at East Stonehouse, Devon, in 1852, and was educated at North Hill Grammar School, under Mr. D. S. Slater, M.A. At the age of fifteen he was articled to the late Robert Hodge, C.E., who was the borough and water engineer of Plymouth. After serving his articles he acted for some time as assistant in the Plymouth office, where he superintended the construction of important tidal sewage outfall works at the

Great Western Docks. Between 1871 and 1874 he acted as assistant surveyor to the corporations of Reigate and Reading while the sewerage works of those towns were in full operation. In 1874 he entered on his duties as assistant to Mr. G. F. Deacon, the borough and water engineer of the city of Liverpool. Here it was that Mr. McCallum gained a wide experience, and on several occasions he was chosen for special work in connection with city and other improvements. In 1876 he was appointed to act as surveyor of Toxteth Park, during the temporary illness of their then surveyor. When only twenty-four years of age he was appointed borough surveyor at Stafford, and there he remained for six years. It was during his term of office that the borough of Stafford carried out many important improvements, such as flood-preventing works, numerous bridges and sewage works, and initiated the new works for a fresh water supply. He also designed the free library and museum for the town and a sanitary depot for the disposal of refuse.

In 1882, out of seventy-three applications, Mr. McCallum was appointed borough engineer of Blackburn, and shortly afterwards water engineer. During his twelve years of office he designed and carried out numerous public improvements, including the Salford bridge improvement, the approach to the railway station, paving works, main sewerage works, sewage irrigation works, new public abattoirs, the Ewood bridge, the Queen's Park, public baths and the twelve miles of tramways. He also designed the works for the destruction of the town's refuse. He supervised the paving of about twenty miles of streets and the laying of over twenty miles of sewers. Mr. McCallum gave considerable attention to the pail system, and he strongly advocated the water-closet system, which is generally adopted in all new property in the town to-day. He superintended the erection of the new infectious diseases hospital, the opening of which was perhaps the last public function the deceased attended. At the International Health Exhibition, 1884, Mr. McCallum was awarded a silver medal for his water-waste prevention cistern and valves. He was an accepted authority on the general sanitation of houses, and at one time he published details of house drainage which are considered among the best extant. He established the "smoke" test for all new drains before they were covered up.

Mr. McCallum published several papers respecting municipal affairs, among which was a valuable contribution entitled "Sanitary Defects of Old Towns, and Suggested Remedies." This was read before the annual meeting of the Sanitary Institute of Grea Britain in 1878. He also gave in a paper which he read at the Lancashire District Meeting of the Association of Municipal and County Engineers, held in Blackburn in 1885, most valuable particulars of municipal and sanitary work in Blackburn. His death will deprive the Association of one of its most esteemed members.

Mr. McCallum died on the 30th of October, 1894, from the effects of an accident which occurred about three weeks previously, by which he sustained a fracture of the leg.

Mr. McCallum was a Member of the Institution of Civil Engineers, and was elected a Member of this Association on the 6th of October, 1882.

EDWIN DAVENPORT LATHAM, of Imeson Terrace, Middlesbrough, died on the 21st of November, 1894. For the last twenty-five years he held the responsible position of surveyor to the Middlesbrough Corporation. Mr. Latham was a native of Nantwich, in Cheshire, and went to Middlesbrough in 1869. Since that time he has discharged his duties with every credit to himself and to the greatest satisfaction of his employers. For many years he held the position of manager of the gasworks, but resigned the post about five years ago. The deceased gentleman was about fifty-six years of age, and leaves a widow and six children, most of whom are grown up. He was held in high respect and esteem by all with whom he came in contact, being of a generous disposition and pleasing manner. His loss will not only be felt by a large circle of friends and acquaintances, but by the members of the Corporation, with whom he has worked so amicably during the time of his employment. Mr. Latham was an Associate Member of the Institution of Civil Engineers, and was elected a Member of this Association in 1873.

JOHN HENRY STRACHAN, born on the 12th of February, 1864, began his engineering career as an apprentice to Messrs. Naylor and Bell, of Newcastle-on-Tyne. After remaining four years with that firm, he acted in 1883 and 1884 as a general assistant to his brother, Mr. George R. Strachan, at that time engineer and surveyor to the Chiswick Local Board. From 1885 to 1889 he was assistant-surveyor to the Brentford Local Board, engaged on sewerage works, on filter-presses for the disposal of sewage sludge, and on the construction of a river wall and of new roads.

In 1889 Mr. Strachan was appointed engineer and surveyor to the Brentford Local Board. During the five years he held that post he designed and carried out—in addition to the usual street and sewerage work—an Isolation Hospital, Market, Fire Station and Swimming Bath. In 1894 he left Brentford to become surveyor to the Heston and Isleworth Board. That post, however, he was unfortunately not destined to hold long—an attack of influenza, followed by pneumonia, proved fatal on the 6th of March, 1895. Mr. Strachan was a capable municipal engineer, of untiring industry, great geniality and scrupulous honesty.—*Excerpt Minutes of Proceedings of the Institution of Civil Engineers,* vol. cxxi. p. 340.

Mr. Strachan was an Associate Member of the Institution of Civil Engineers, and was elected a Member of this Association on the 8th of June, 1889.

James MacRitchie was born in Scotland in 1848; he was educated at Dollar and at Edinburgh and Glasgow Universities. He was afterwards articled to a civil engineering firm in Glasgow and was employed on the construction of the Albert Bridge and on Parliamentary work. After completing his term of apprenticeship Mr. MacRitchie took up an appointment in Calcutta, where he was engaged in hydraulic and sanitary work. He was afterwards in the employ of the Japanese government for a period of about eight years, and had charge of the government lighthouses. On quitting the service of the Japanese, Mr. MacRitchie was for some time engaged in South America on waterworks, gasworks and tramway construction.

Mr. MacRitchie went to Singapore towards the end of 1883 to fill the office of municipal engineer, a post he held up to the time of his death. Mr. MacRitchie carried out works of considerable importance at Singapore; besides completing the Coleman Bridge, several other bridges were designed by him and erected under his superintendence. His name is also honourably associated with the development of the waterworks, including the extension of the impounding reservoir, the construction of filter beds, the erection of large additional pumping plant and the laying of mains. Mr. MacRitchie reorganised the drainage of Singapore, and effected great improvements in the sanitary arrangements of the town.

During the last ten years the three principal markets have been rebuilt. The abattoirs also, which have been brought into operation in the present year, were entirely designed by him on his return from leave in 1888 and as a result of his study of the principal abattoirs and meat markets at home.

Mr. MacRitchie died from inflammation of the brain on the 26th of April, 1895. He was a Member of the Institution of Civil Engineers and was elected a Member of this Association on the 19th of January, 1895.

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THE ASSOCIATION OF MUNICIPAL AND SANITARY ENGINEERS AND SURVEYORS.

CONTENTS OF VOLUME XIX.

PAPERS AND DISCUSSIONS:

PROGRESS OF MUNICIPAL AFFAIRS IN BELFAST.—J. C. BRETLAND.
LONDONDERRY, WITH SOME NOTES ON ITS ENGINEERING AND SANITARY PROGRESS. W. J. ROBINSON.
RIVER WALL WORKS AT FULHAM.—J. P. NORRINGTON.
WESTERN AUSTRALIAN WOODS FOR PAVING.—J. P. NORRINGTON.
FULHAM STABLES.—J. P. NORRINGTON.
CABLE TRAMWAY IN LONDON BETWEEN KENNINGTON AND STREATHAM HILL.
REGENT'S PARK ELECTRIC LIGHTING STATION, ST. PANCRAS.—PROF. H. ROBINSON.
PUBLIC WORKS OF DUDLEY.—J. GAMMAGE.
SEWERAGE AND SEWAGE DISPOSAL WORKS OF DUDLEY.—E. D. MARTEN.
MAIN FEATURES OF THE MANCHESTER MAIN DRAINAGE.—J. ALLISON.
A CONSIDERATION OF SOME OF THE CONDITIONS REQUISITE FOR OBTAINING UNDERGROUND WATER SUPPLIES.—G. HODSON.
MUNICIPAL WORK IN HARROGATE.—S. STEAD.
WATER SUPPLY OF HARROGATE.—E. W. DIXON.
SANITARY WORK IN BURY ST. EDMUNDS.—J. C. SMITH.
LIGHTING THE LYNN SHIP CHANNEL.—E. J. SILCOCK.
WATER METERS FOR MUNICIPAL PURPOSES.—B. GODFREY.
PRESIDENT'S ADDRESS.—J. T. EAYRS.
PARISH AND DISTRICT COUNCILS BILL, 1893.—R. GODFREY.
ELECTRICAL MAINS AND METHODS OF LAYING.—C. H. W. BIGGS.
MUNICIPAL ELECTRICITY WORKS.—R. HAMMOND.
SEWAGE DIFFICULTIES AT NUNEATON.—J. S. PICKERING.
SELECTION AND CULTIVATION OF TREES FOR ROADS.—F. SMYTHE.
PRIVATE STREET WORKS ACT, 1892.—G. B. LAFFAN.
PORTLAND CEMENT, VALUE OF FINE GRINDING.—H. K. G. BAMBER.
NOTES ON HYDRAULIC FORMULÆ.—W. S. CRIMP.
NOTES ON ROWLEY RAG STONE.—S. S. PLATT.
OVERHEAD ELECTRIC TRAMWAYS.—A. DICKINSON.
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CONTENTS OF VOLUME XX.

PAPERS AND DISCUSSIONS:

MAIN SEWERAGE, STORM OUTFALL AND SEWAGE DISPOSAL WORKS OF LEICESTER.—E. G. MAWBEY.

CARRIAGE-WAY PAVEMENTS, WITH SPECIAL REFERENCE TO WHAT HAS RECENTLY BEEN DONE IN THE STRAND, LONG ACRE, &c.—C. MASON.

JOINTING OF WOOD PAVEMENTS.—W. N. BLAIR.

HOSPITAL TENTS AT WIMBLEDON.—C. H. COOPER.

MACHINERY AS APPLIED TO THE BREAKING UP OF MACADAM.—A. E. COLLINS.

SOME MUNICIPAL WORKS IN READING.—A. E. COLLINS.

RECENT EXTENSIONS OF THE READING WATERWORKS, AND THE USE OF POLARITE FOR FILTRATION.—A. T. WALKER.

WATER AND SEWAGE WORKS, &c. OF KEIGHLEY.—W. H. HOPKINSON.

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SHORT DESCRIPTION OF THE METHOD OF DETECTING WASTE OF WATER AT TORQUAY.—T. S. WEEKES.

CHAPEL HILL METEOROLOGICAL OBSERVATORY, TORQUAY.—A. CHANDLER.

PRESIDENT'S ADDRESS.—A. M. FOWLER.

ARRANGEMENTS FOR STERILISING CHOLERA DEJECTA, &c., ADOPTED AT NEWCASTLE-ON-TYNE.—W. G. LAWS.

SOME EXPERIMENTS WITH MODEL WHEELS AND ROAD COATINGS.—T. CODRINGTON.

DEVELOPMENT OF SANITATION IN AMERICA.—LIEUT.-COL. A. S. JONES.

IRISH COUNTY SURVEYORSHIPS AND THE GRAND JURY SYSTEM OF IRELAND.—R. B. SANDERS.

MAINTENANCE OF MAIN ROADS IN URBAN DISTRICTS.—J. E. SWINDLEHURST.

BRADFORD CORPORATION ELECTRICITY SUPPLY, WITH THE RESULTS OF FOUR YEARS' WORKING.—J. N. SHOOLBRED.

ELECTRIC STREET TRAMWAYS.—R. HAMMOND.

MINERAL ROCK ASPHALT.—H. D. BLAKE.

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